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A Climatological Study of the AFGL Mesonetwork Volume I

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This study represents the first step in the development and analysis of an edited mesoclimatological data base of four years of observations by the 26 automated weather stations of the AFGL Mesonetwork. The first section describes the station network that existed during the period of operation, September 1972 through July 1976; the weather instruments that were utilized in the network; and the methodology of the data-editing routine.

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20. Abstract (continued)

In the final section, the climatology derived from one year of data for half of the stations is presented. Selection of stations was based on topographic features or location in the network. Sites represented are located at towers, runways, swamps, valleys, hills and, finally, at the coast line.

The climatology includes extinction coefficient, and wind direction and speed. Cumulative frequency curves rank the stations according to frequency of visibility restrictions and wind speeds. Highest frequencies of visibility restriction were observed at the hill sites, lesser frequencies at coastal sites, runway sites and, finally, the lowest frequencies at the valley sites. Highest frequencies of high wind speeds occurred at the hill and coastal sites. The valley sites, due mainly to the sheltering effect of surrounding topography, showed the lowest frequencies.

Diurnal variations of extinction coefficient and wind speed throughout four months representative of the four seasons are graphed. Strong diurnal variation of visibility with nocturnal maxima in fall and summer are shown. The effects of coastal fog in June were quite apparent. Strong diurnal variation of wind speed was apparent for all seasons.

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Preface

The efforts of Mrs. Maureen Hampton and Mrs. Joan Ward, Systems and Applied Sciences Corporation, in the formulation of the data-editing and climatology programs are gratefully acknowledged. Many individuals from the Air Force Geophysics Laboratory assisted in the program; in particular, Captain Edward B. Geisler assumed the editing responsibility for a three-month period during the author's absence. In addition, the author is most grateful to Mr. Donald Chisholm and Dr. Stuart Muench for many valuable discussions concerning the study, and especially to Mr. Chisholm for many helpful comments on the paper itself. The author also wishes to acknowledge the assistance of Mrs. Alysia Pelletier in typing the manuscript.

A Climatological Study of the AFGL Mesonetwork, Volume I

1. INTRODUCTION

From 1972 to 1976, the Air Force Geophysics Laboratory (AFGL) conducted an experimental program to explore the benefits that could be achieved in short-range (0-3 hours) forecasting from the use of automated weather observations.[1] To accomplish this goal, a field test facility was established in the eastern part of Massachusetts. It consisted of 25 surface weather stations and one instrumented tower. The network was under the control of a computer located at Hanscom Air Force Base, Massachusetts, and automated techniques were utilized to acquire, process, display, and archive the data for use in real-time, short-range forecasting experiments, and for the development of objective mesoscale prediction and analysis techniques.

The forecasting experiments[2] were conducted as a competition between forecasters. One forecaster based his forecasts on conventional weather data only, while the other forecaster was allowed to use both conventional and mesoscale

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1. Hering, W. S., Brown, H. A. and Muench, H. S. (1972) Mesoscale Forecasting Experiment, Bull. Am. Meteorol. Soc., 53, 12:1180-1183.

2. Hering, W. S. and Quick, D. L. (1974) Hanscom visibility forecasting experiments, Proc. 5th Conf. on Weather Forecasting and Anal., pp. 224-227.

data. The forecasters who had access to the more detailed data were found to be more skillful (about 10-15 percent) than those who relied on conventional data alone.

Further studies[3-5] revealed the time and space characteristics of visibility in fogs and advective weather patterns. Objective techniques were also developed to aid the forecaster in the use of the complex and voluminous mesoscale data in his forecasting efforts.

Since visibility was recognized to be one of the most significant operational aviation weather parameters, emphasis was placed on it throughout the forecasting experiments. In order to carry out these experiments, however, a full complement of weather sensors was established at each station. The basic instrumentation at each site observed visibility, wind direction, wind speed, temperature, and dewpoint.

This represents the first step in the development and analysis of an edited mesoclimatological data base of the four years of observations by the 26 automated weather stations. In Volume I, the first section will describe the station network that existed between 1972 and 1976, the weather instruments, and the methodology of the data-editing routine. In the final section, the mesoclimatology derived from one year of data, for half the stations, will be presented. In Volume II, a five-part statistical summary of surface weather observations collected by the thirteen stations during the one-year period will be documented.

2. SURFACE NETWORK

In planning the layout of the new network, it quickly became apparent that a circular network surrounding Hanscom Air Force Base to the distance required would be prohibitively expensive. The final plan called for the establishment of an elliptical-shaped network beginning at Hanscom Air Force Base and extending to the northeast to Hampton, New Hampshire. The density of the network stations was greatest in the southwest, near Hanscom, and least in the northeast. This

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3. Chisholm D. A. and Kruse, H. (1974) The Variability of Visibility in the Hanscom Mesonetwork: A Preliminary Assessment, AFCRL-TR-74-0265, AD784791.

4. Tahnk, W. R. (1975) Objective Prediction of Fine Scale Variations in Radiation Fog Intensity, AFCRL-TR-75-0269, ADA014774.

5. Chisholm, D. A. (1976) Objective Prediction of Mesoscale Variations of Sensor Equivalent Visibility During Advective Situations, AFGL-TR-76-0132, ADA030332.

rationale allowed forecasting for Hanscom Air Force Base in those situations with weather systems propagating to the southwest (i.e., winter "nor'easter") from the coast. On the other hand, if weather systems moved in from the southwest, provision was made to forecast for one of the sites near Hampton, New Hampshire. Careful consideration was also given to specific site locations in order to determine the detailed behavior of mesoscale weather systems under a variety of topographical settings. Thus, individual stations were positioned on hilltops, in valleys, on flat meadows, along the seaside, and in swampy lowlands.

The network of stations established during the four-year period is shown in Figure 1. Two network configurations are illustrated in the figure. The first

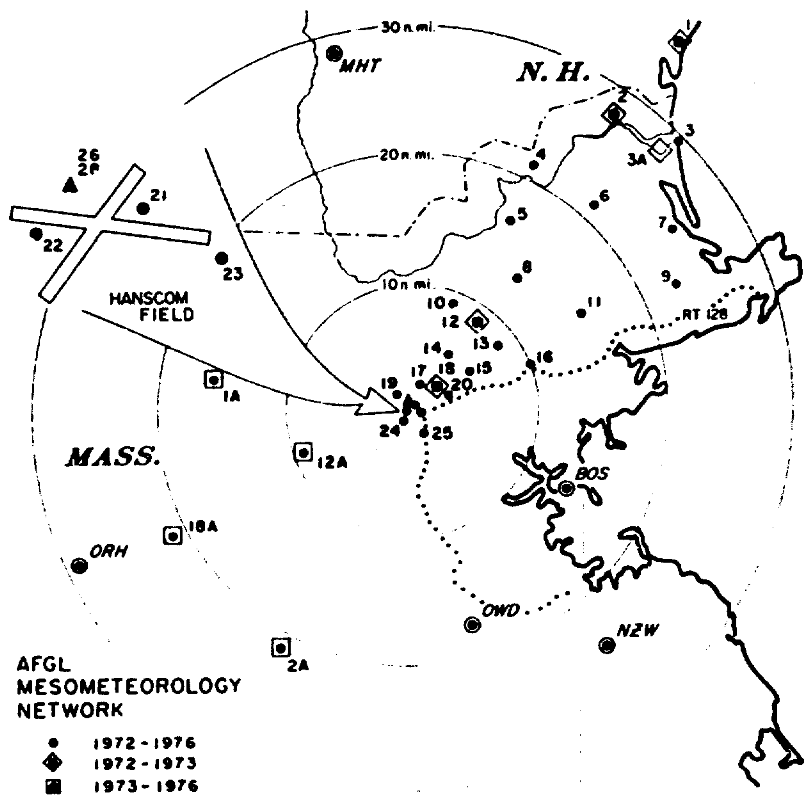

Figure 1. Network of Remote Surface Weather Stations. An enlarged view of Hanscom Air Force Base shows the runway (solid circles) and tower (solid triangle) locations

network, denoted by dots and diamond-dots, located to the northeast of Hanscom Air Force Base, was operated between Fall 1972 and Spring 1973. During this period, the forecasting experiments revealed that storm systems traveling from the northeast at relatively slow speeds could be tracked adequately with fewer stations. During the same period, weather systems traveling from the southwest, at a much higher speed and frequency than expected, highlighted a need to extend the network to the southwest. A decision was made, therefore, to close four stations to the northeast of Hanscom and relocate them to the southwest, as denoted in Figure 1 by square-dots. Except for the minor relocation of the Plum Island site (PLM-3 to PLM-3A), the second configuration was maintained until the completion of the project. Station particulars, e.g., call letters and numbers, latitude, longitude and ground elevation, are listed in Table 1. Topographical charts of the area surrounding each station are shown in Appendix A.

Table 1. Mesonetwork Station Identification and Location

STATION IDENT.			LOCATION		ELEVATION		SITE
NO.	CALL LTR.	NAME	LAT	LONG	Meters	Date Collection Began	Characteristic
1	HMP	Hampton, NH	42 55'25"	70 49'00"	2	4 Sept 1972	Coastal
2	AMS	Amesbury, MA	42 51'15"	70 56'15"	87	4 Sept 1972	Hill
3	PLM	Plum Island, MA	42 49'00"	70 49'00"	3	4 Sept 1972	Coastal
4	HAV	Haverhill, MA	42 47'20"	71 04'08"	49	4 Sept 1972	Hill
5	LAW	Lawrence, MA	42 42'55"	71 07'10"	50	4 Sept 1972	Runway
6	GEO	Georgetown, MA	42 44'10"	70 07'10"	23	4 Sept 1972	Valley
7	NIP	North Ipswich, MA	42 43'00"	70 50'40"	17	4 Sept 1972	Coastal
8	BSH	Andover,MA-Bos Hill	42 38'50"	71 05'40"	114	4 Sept 1972	Hill
9	SAG	Sagamore Hill, MA	42 37'50"	70 48'55"	56	4 Sept 1972	Hill
10	TWK	Tewksbury, MA	42 36'45"	71 12'55"	35	4 Sept 1972	Valley
11	MID	Middleton, MA	42 35'55"	70 59'10"	64	4 Sept 1972	Hill
12	AVC	Wilmington,MA-AVCO	42 35'35"	71 09'35"	47	4 Sept 1972	Hill
13	HAC	Reading, MA-P.S.	42 33'05"	71 08'00"	23	4 Sept 1972	Swamp
14	BIL	Billerica, MA	42 32'40"	71 13'10"	32	4 Sept 1972	Valley
15	CHS	Wilmington,MA-P.S.	42 31'45"	71 10'15"	27	4 Sept 1972	Valley
16	CCG	Camp Curtis Guild	42 31'45"	71 04'40"	30	4 Sept 1972	Valley
17	VAH	Bedford,MA-VA Hosp.	42 30'20"	71 16'10"	38	4 Sept 1972	Valley
18	MTR	Bedford,MA-MITRE	42 30'10"	71 14'10"	38	4 Sept 1972	Valley
19	NKE	Bedford,MA-Nike Site	42 29'25"	71 18'15"	49	4 Sept 1972	Hill
20	RKO	Burlington,MA-P.S.	42 29'15"	71 13'10"	40	4 Sept 1972	Swamp
21	NRY	Hanscom N Runway	42 28'20"	71 17'05"	38	4 Sept 1972	Runway
22	WRY	Hanscom W Runway	42 28'15"	71 17'55"	38	4 Sept 1972	Runway
23	ERY	Hanscom E Runway	42 28'05"	71 16'10"	38	4 Sept 1972	Runway
24	DMP	Hanscom Landfill	42 27'35"	71 18'05"	41	4 Sept 1972	Swamp
25	DPW	Lexington, MA	42 26'30"	71 15'35"	53	4 Sept 1972	Valley
26	TWL	Hanscom Tower(lower)	42 28'35"	71 17'40"	43	4 Sept 1972	Tower
28	TWH	Hanscom Tower(upper)	42 28'35"	71 17'40"	43	4 Sept 1972	Tower
1A	DEV	Fort Devens, MA	42 30'40"	71 38'10"	79	14 June 1973	Plateau
2A	MIL	Milford, MA	42 09'20"	71 30'55"	84	31 Aug 1973	Valley
3A	PLM	Plum Island, MA-APT	42 47'45"	70 50'10"	2	20 June 1974	Coastal
12A	SUD	Sudbury, MA	42 25'08"	71 28'32"	64	9 June 1973	Valley
18A	SHR	Shrewsbury, MA	42 18'45"	71 42'35"	165	27 June 1973	Valley

3. STATION INSTRUMENTATION

An example of an automated weather station (WRY-22) is shown in Figure 2. The instruments at the three runway stations (21, 22, and 23) were mounted on

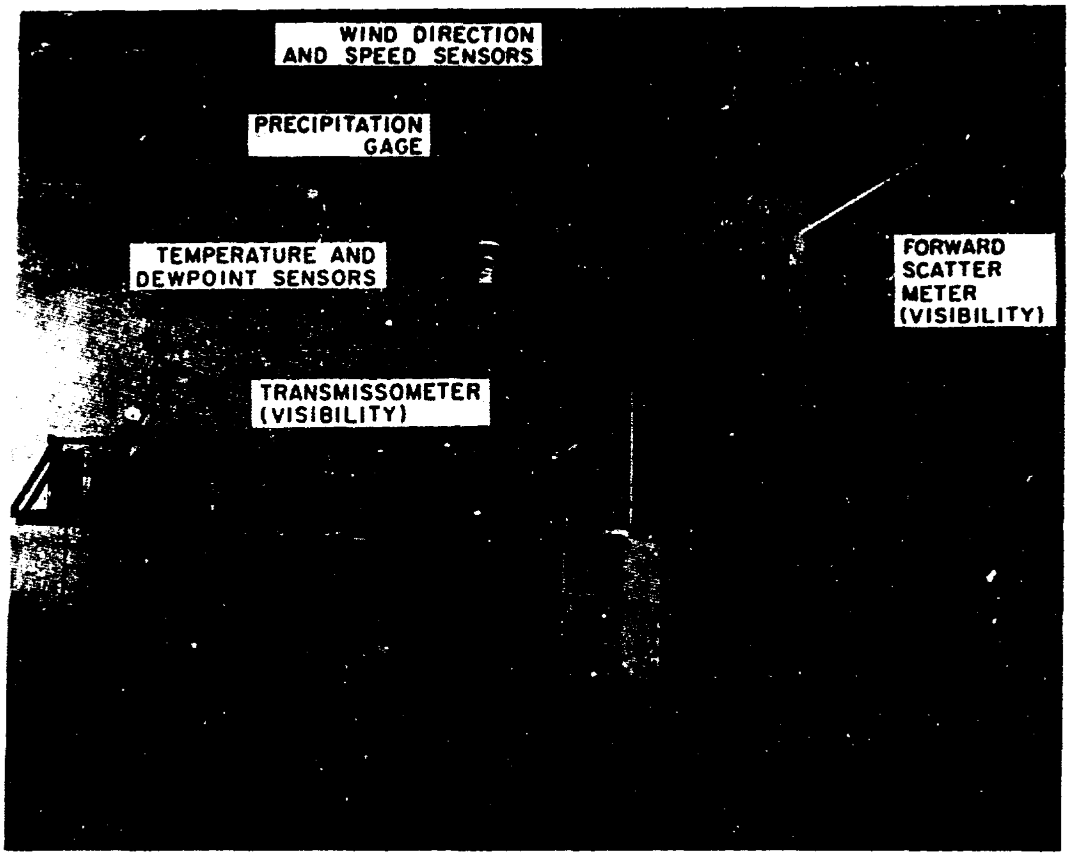

Figure 2. Picture of Station (WRY) Showing the Mesonetwork Weather Instruments (Visibility, Wind, Precipitation and Temperature-Dewpoint) and the Transmissometer

cross arms at a height of 4 m. The remaining stations had instruments mounted at a height of 8 m. The tower (26-28) was instrumented at two levels, 30 and 45 m.

All stations were equipped with sensors that reported wind direction, wind speed, visibility, temperature, and dewpoint. In addition, ten stations were equipped with heated precipitation gauges, while four were augmented with transmissometers.

The temperature-dewpoint instrument (EG&G 110S-M) utilized a thermoelectrically cooled mirror with optical sensing of the liquid or frozen condensate. The temperature and dewpoint measurements were obtained with platinum-resistance thermometers that sensed the temperature of the condensate surface and the ambient air. Temperature range of the instrument was from -80° to 120°F with an accuracy of $\pm 0.5^{\circ}$F.

The wind set (Climatronics WM-1) was relatively new on the market when it was acquired for the mesonetwork. Special features of the cup and vane set, which made it desirable for our use, were low start speed, fast response, and a friction-free transducer for sensing wind direction.

The instrument used to determine visibility (EG&G 207 Forward-Scatter-Meter) was developed under AFGL contract. Its special features were single-unit construction, short-path-length, and good agreement with conventional larger sample volume visibility instruments. The set had the ability to determine visibility over a range of 70 m to 7000 m. More detailed discussion on the forward scatter meter may be found in other studies.[7-9]

The precipitation and transmissometer data were not included in the climatological study. The rationale for operation of the transmissometers was merely to provide consistency checks with the forward-scatter-meters (FSMs) in the early stages of the project, under widely varying visibility conditions. After a very short time, the reliability of the FSMs was such that these checks were dispensed with. The inclusion of the transmissometer would, therefore, only provide redundant information.

In the case of precipitation gauges, considerable noise, generated by spurious counts of the instrument in response to wind gusts, noisy data lines, and cycling of the heating mechanism, rendered the data unsuitable for analysis.

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7. Muench, H. A., Moroz, E. Y. and Jacobs, L. P. (1974) Development and Calibration of the Forward Scatter Visibility Meter, AFCRL-TR-74-0145, AD783270.

8. Chisholm, D. A. and Jacobs, L. P. (1978) An Evaluation of Scattering-Type Visibility Instruments, AFCRL-TR-75-0411, ADB010224L.

9. Brown, H. Albert (1979) Preliminary Assessment of an Automated System for Detecting Present Weather, AFGL-TR-79-0137, ADA078031.

4. DATA REDUCTION AND EDITING

The mesonet magnetic tapes are the basic building blocks of the mesoclimatology data base. Each tape contains approximately three days of data. During the operating period of the mesonetwork, from 1972 to 1976, 420 tapes were generated. It took 10 seconds for the Honeywell 324 computer (used to operate the mesonetwork) to query all sensors at all the stations. Thus, every sensor was sampled six times per minute. It was decided to edit each tape and generate one-minute averages of all the variables with the corrected data. This information could be stored on a master magnetic tape and achieve a reduction factor of about 10, which would greatly facilitate the use of the data in time and space variability studies. At the same time, a mesoclimatology of the network could be generated.

The initial processing of the tapes, which provides a statistical summary of all the meteorological variables, included some automatic editing features. For example, time consistency is checked continuously. Any sensor value that has an erroneous time associated with it is automatically suppressed. Dewpoint values that exceed the corresponding temperature observations by 0.5^{o} are suppressed, while the dewpoint average for a given minute is eliminated if its standard deviation for that minute exceeds 10^{o}F. This type of error coincides mainly with the twice-daily automatic recycling calibrations of the dewpoint sensor to clean the mirror. An edit is also made on wind-direction values and eliminates any that do not fall in the range of 0 to 360^{o}. Figure 3 is one of the typical output pages

120 1973

GMT TIME	ID		N	N1	TT	ST	N	N1	TD	STD	N	N1	DD	FF	SDD	DX	FX	SV	N	N1	EXCO	EMX	SDE
2240-2300	9	SAG	126	21	278	8	125	21	191	17	81	21	316	152	178	309	266	56	113	21	2	6	2
2301- 0	9	SAG	357	60	262	16	356	60	176	16	236	60	319	162	159	309	226	53	376	60	9	8	1
TOTAL			126	1	278		125	1	191		81	1	316	152	170	309	266		113	1	2	6	
121 1973																							
1- 100	9	SAG	356	60	296	5	355	60	160	9	279	60	313	146	160	301	223	93	321	60	1	6	1
101- 200	9	SAG	333	60	293	17	333	60	169	17	220	60	311	135	168	318	266	60	329	60	1	6	2
201- 300	9	SAG	291	60	247	7	291	60	160	16	222	60	310	137	160	296	260	60	349	60	1	7	2
301- 400	9	SAG	357	60	238	10	357	60	136	8	233	60	320	126	165	307	226	58	358	60	0	1	0
401- 500	9	SAS	360	60	230	4	357	60	119	16	269	60	315	117	166	296	193	56	352	60	0	0	0
501- 600	9	SAG	357	60	227	4	357	60	110	18	238	60	316	112	120	290	180	60	356	60	0	0	0
601- 700	9	SAG	359	60	217	20	359	60	99	10	266	60	318	106	125	323	195	47	355	60	0	0	0
701- 800	9	SAG	356	60	206	11	358	60	19	6	263	60	313	102	115	326	183	37	356	60	1	0	0
801- 900	5	SAG	360	60	197	17	360	60	81	9	253	60	319	90	105	301	130	30	359	60	0	0	0
901-1000	9	SAG	360	60	180	16	360	60	77	8	264	60	324	67	86	315	110	33	350	60	1	0	0
1001-1100	9	SAG	360	60	183	10	360	60	75	6	271	60	320	50	70	317	93	26	357	60	1	0	0
1101-1200	9	SAG	360	60	170	18	360	60	72	13	318	60	317	66	56	313	80	20	352	60	0	0	0
1201-1300	9	SAG	350	60	177	17	350	60	73	9	301	60	326	52	61	327	82	19	346	60	1	0	0
1301-1400	9	SAG	359	60	195	17	359	60	76	7	302	60	326	60	58	333	86	23	360	60	1	0	0
1401-1500	9	SAG	359	60	226	10	359	60	79	11	326	60	319	47	57	302	76	18	360	60	0	0	0
1501-1600	9	SAG	350	60	260	15	350	60	82	12	319	60	201	28	38	309	85	18	303	60	0	0	0
1601-1700	9	SAG	360	60	289	10	359	60	90	10	309	60	293	26	78	307	66	10	324	60	0	0	0
1701-1800	9	SAG	360	60	310	11	360	60	81	22	330	60	274	16	16	281	42	13	361	60	0	0	0
1801-1900	9	SAG	360	60	340	10	360	60	103	13	330	60	294	15	16	266	65	13	267	60	0	0	0
1901-2000	9	SAG	352	60	362	9	350	60	123	11	366	60	271	13	15	261	62	12	276	60	0	0	0
2001-2100	9	SAG	316	60	375	5	316	60	106	12	329	60	290	17	10	239	60	19	209	60	0	0	0
2101-2200	9	SAG	356	60	382	9	357	60	107	12	339	60	261	10	11	262	35	12	310	60	0	0	0
2201-2300	9	SAG	327	60	340	13	326	60	160	8	351	60	203	20	22	197	42	16	360	60	0	0	0
2301- 0	9	SAG	360	60	330	12	360	60	110	8	361	60	303	37	38	306	40	8	360	60	0	0	0
TOTAL			8075	23	296		8060	23	101		6590	23	311	63	77	296	260		7735	23	0	0	

Figure 3. An Example of the Editing-Program Output Illustrating the Hourly Averages of Temperature, Dewpoint, Wind Direction, Wind Speed and Extinction Coefficient for Station 9 - SAG on January 20 and January 21, 1973

generated by the program for each tape processed. It summarizes, generally, in hourly increments, the meteorological observations for each station. On the upper left, the first line gives month, day, and year (e.g., 120 1973 denotes January 20, 1973). TIME indicates the hour or portion of the hour (GMT) for the following calculations:

ID	- Station number and station call letter (see Table 1).
N	- Number of 6-second data points in the temperature, dewpoint, wind direction, wind speed, and visibility averages.
N1	- Number of one-minute averages that made up the subsample average.
TT	- Average temperature value (in 0.1°F) for the time interval noted.
ST	- Standard deviation of temperature. (0.1°F)
TD	- Average dewpoint value (in 0.1°F) of the time noted.
STD	- Standard deviation of dewpoint (0.1°F).
DD	- Vector mean wind direction (degrees) for the time interval noted.
FF	- Vector mean wind speed (0.1 knots) for the time interval noted.
SCM	- Scalar mean wind speed (0.1 knots) for the time interval noted.
DX	- One-minute average wind direction at time of maximum one-minute average speed.
FX	- Maximum one-minute average wind speed during time interval sampled.
SV	- Vector Standard Deviation of wind (0.1 knot).
EXCO	- Average extinction coefficient (in $10^{-4}m^{-1}$) for the time interval noted.
EMX	- The maximum one-minute average extinction coefficient ($X10^{-4}m^{-1}$) observed during the time interval.
SDE	- The standard deviation of the extinction coefficient.

With this output, it is possible to edit each station's complement of instruments rapidly, on an hour-to-hour and daily basis. In this particular figure, the temperature and dewpoint appears to be operating satisfactorily throughout the day. Columns headed by N and N1 indicate that sixty minutes of data are being collected in each hour, and that almost all one-minute averages are based on six samples.

The wind direction and speed (DD and FF) also appear to be operating satisfactorily, and sixty minutes of data are represented in the hourly average, but there are fewer than the maximum data points (N) being collected each hour. This is undoubtedly due to a noisy channel causing some data to have been rejected by the mesonetwork computer. The columns headed DX and FX show that the period began with high winds (20-26 knots) from the northwest that decreased during the day to about 4-6 knots from the west to southwest. The visibility meter shows unrestricted visibility during this period, and a drop of hourly data points (N) between 1700 and 2100 GMT, again probably due to noisy data lines.

Figure 4 shows the second form of output from the initial editing program. It follows the individual station outputs and gives a summary, by day, of all the

121 1973

GMT TIME		ID		N	N1	TT	ST	N	N1	TD	STD	N	N1	DD	FF	SCH	DX	FX	SV	N	N1	EXCO	ENV	SNF
1-	0	1	HMP	0267	23	252	64	0128	23	91	23	0001	23	260	15	14	243	64		7843	23	0	1	
1-	0	2	[illegible]	[illegible]	23	[illegible]	67	[illegible]	23	90	24	[illegible]	[illegible]	189	44	[illegible]	114	226		[illegible]	23	0	0	
1-	0	3	PLN	0254	23	260	57	0157	23	108	30	7304	23	285	119	170	294	301		7828	23	0	7	
1-	0	4	HAV	0269	23	281	61	0185	23	70	22	6720	23	204	47	61	283	170		8153	23	0	3	
1-	0	5	LAN	7857	23	259	66	7594	23	65	22	6501	23	308	85	90	312	342		7109	23	0	[illegible]	
1-	0	6	GEO	0277	23	248	50	0274	23	102	30	7020	23	306	63	60	312	213		7666	20	0	7	
1-	0	7	HIP	0255	23	257	63	0136	23	99	25	6704	23	308	61	60	313	219		7780	23	6	7	
1-	0	8	[illegible]	[illegible]	[illegible]	247	60	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	304	30	30	[illegible]	303		6096	[illegible]	0	54	
1-	0	9	SAG	0079	23	254	64	0066	23	101	27	6590	23	311	69	77	294	260		7719	23	0	7	
1-	0	10	THH	0266	23	263	66	0172	23	40	24	6298	23	311	44	73	306	222		7362	23	0	6	
1-	0	11	HID	0293	23	256	68	0155	23	91	23	6296	23	327	69	79	317	283		7358	23	0	15	
1-	0	12	AUG	0247	20	277	61	0004	23	41	94	6662	20	314	95	41	313	220		6746	23	0	3	
1-	0	13	HAC	0276	23	203	61	7319	23	73	25	6914	23	300	104	109	301	335		7995	23	0	1	
1-	0	14	[illegible]	0276	23	260	62	[illegible]	23	44	21	[illegible]	23	309	69	75	304	271		7696	24	0	0	
1-	0	15	CHS	0295	23	262	65	0176	23	71	22	6604	23	309	60	65	314	264		8112	23	0	3	
1-	0	16	CCC	0276	23	274	66	0162	23	44	40	6708	23	311	20	34	323	188		7487	23	0	6	
1-	0	17	VAN	0208	23	281	68	0155	23	66	33	6737	23	322	61	69	325	222		7715	23	0	5	
1-	0	18	MTR	0278	23	266	64	0147	22	64	23	6407	23	1	64	69	4	265		7645	23	0	1	
1-	0	19	NKE	0279	23	267	72	7959	21	-580	0	6731	23	307	98	100	314	388		7615	23	0	1	
1-	0	20	[illegible]	0279	23	240	65	0101	[illegible]	44	25	5009	23	[illegible]	[illegible]	49	333	263		0014	23	0	1	
1-	0	21	NRY	0260	23	-500	0	0	0	999	999	6600	23	296	91	96	297	293		7392	23	0	1	
1-	0	22	WRY	0273	23	266	60	0006	23	63	27	7010	23	312	66	65	323	200		7600	23	0	6	
1-	0	23	ERY	0260	23	-500	0	0	0	999	999	7163	23	311	82	98	311	266		7756	23	0	7	
1-	0	24	[illegible]	0276	23	273	64	0176	23	79	80	7001	23	305	65	72	290	260		7691	24	6	1	
1-	0	25	[illegible]	0256	23	765	65	0	0	999	999	6046	23	327	82	89	314	262		7682	23	0	1	
1-	0	26	TWL	6475	20	-531	55	[illegible]	11	-542	[illegible]	0108	23	44	0	7	45	7		6742	[illegible]	1	1	
1-	0	28	TWH	0272	23	-508	0	0	0	999	999	4265	23	230	6	6	730	17		7131	23	0	1	

Figure 4. An Example of the Editing-Program Output Illustrating the Daily Averages of the Meteorological Variables (see Figure 3) for all Stations in the Mesonetwork on January 21, 1973

stations. Column headings are the same except that N1 denotes the number of hours that data were available during the period. This particular output is for January 21, 1973. The station numbers and call letters are listed in sequence and it becomes an easy task to scan each column (TT, TD, DD, FF, and EXCO) and compare daily averages. Inoperative or malfunctioning sensors are thus quickly determined. In the temperature column, TT, stations 21 (NRY), 23 (ERY), 26 (TWL), and 28 (TWH) report values that indicate the temperature sensors were not operating properly and, therefore, should be suppressed. The dewpoint column, TD, shows malfunctions or inoperative sensors at stations 19, 21, 23, 25, 26, and 28. The wind direction and speed columns, DD and FF, show suspicious average wind data at stations 2, 18, 26, and 28. Reference to the individual outputs for each station resulted in these data being deleted. Finally, a check of the visibility data, EXCO, revealed that all stations were reporting unlimited visibility and valid measurements during this day.

The next five figures are examples of frequency distributions of one-minute averages that are generated for each tape. These frequency distributions are constructed for wind direction -- Figure 5; windspeed, Figure 6; temperature, Figure 7; dewpoint, Figure 8; and visibility, Figure 9.

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		HMP	ANS	PLH	HAV	LAW	SEQ	NTP	BTM	TAG	THK	MTN	AVC	HAC	BIL	CHS	CCG	VAH	MTR	NKF	RKO	HRY	VRY	ERY	ONF	OPN	TML	THH
0<=X< 10	1	4	5		44	1		1		15	0	7	44	12	4	7	80	40	624	4	20	10	18	20	7	41	3	4
10<=X< 20	2	5	722		16		2		1	7	0	2	3	9	1	3	8	15	180	4	15	11	5	5	7	30	232	
20<=X< 30	3	4	44		44		2			3	15	4		6		4	4	21	67	16	22	14	9	9	14	40		4
30<=X< 40	4	6	5		15		1				21	2		4	9	3	4	34	18	18	12	17	2	7	18	75		1
40<=X< 50	5	[illegible]	[illegible]		[illegible]		[illegible]		[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
50<=X< 60	6	7	3		72		4	1	1	2	30	1	3	18	23		3	37	6	37	3	35	5	13	63	22		2
60<=X< 70	7	4			40		4		1	4	44			38	43	3	1	28	7	11	1	78	63	23	67	78		7
70<=X< 80	8	6	8		56		3		1	7	37			48	92		6	28		33	12	66	60	50	20	20		4
80<=X< 90	9	10	10		60	7	4		4	4	49		4	74	51	4	22	27		29	23	42	65	61	12	30		2
90<=X<100	10	42	49		97	94	3		4		57		53	133	86	9	67	27	1	25	29	20	30	91	8	76		3
100<=X<110	11	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	24	40	[illegible]	[illegible]	[illegible]	19	[illegible]	44	[illegible]		[illegible]
110<=X<120	12	53	844	39	97	198	21		173	1	139		231	99	60	12	91	22	15	37	61	76	25	99	29	36		
120<=X<130	13	69	4	169	44	96	34		109	3	147		183	46	46	47	114	16	28	116	86	152	46	133	44	41		7
130<=X<140	14	68	2	273	36	38	161	2	96	6	121	11	61	79	92	44	129	42	75	191	139	100	80	136	92	75		31
140<=X<150	15	124		120	[illegible]	63	169	4	47	38	[illegible]	[illegible]	40	40	46	76	106	40	70	140	174	75	170	144	82	70		63
150<=X<160	16	719	1	66	39	13	201	49	30	176	65	318	67	68	58	77	93	94	38	109	119	90	164	90	99	176		49
160<=X<170	17	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		33
170<=X<180	18	37	6	136	31	75	92	200	8	256	137	82	52	142	102	76	72	43	52	120	107	121	108	190	71	287		20
180<=X<190	19	40		250	46	44	84	40	34	141	40	36	84	140	204	43	67	33	65	286	148	97	117	137	109	285		27
190<=X<200	20	93		456	63	306	136	33	250	294	106	66	100	206	606	74	120	79	107	317	102	159	197	127	150	289		199
200<=X<210	21	417		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	872	47	164	110	79	334	296	167	179	180	361	127		76
210<=X<220	22	90		492	260	152	229	179	437	396	226	250	172	169	108	60	177	216	40	473	390	796	263	120	490	137		13
220<=X<230	23	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		43
230<=X<240	24	906		240	640	573	400	932	289	706	277	416	259	319	41	287	173	510	78	219	243	267	359	213	107	326		2500
240<=X<250	25	874	3	97	368	283	384	[illegible]	184	230	237	360	370	288	43	484	367	314	171	180	146	186	216	363	74	307		125
250<=X<260	26	433	1	89	248	116	239	265	47	123	154	327	491	145	41	591	162	190	191	49	71	77	151	407	46	197		117
260<=X<270	27	231	25	63	275	49	234	247	31	45	116	237	284	108	22	293	130	149	249	43	49	47	95	142	36	91		91
270<=X<280	28	116	35	49	107	44	170	66	35	62	103	140	167	77	34	211	94	94	276	21	27	44	76	67	42	49		192
280<=X<290	29	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		463
290<=X<300	30	113	6	361	174	179	260	47	43	130	125	69	131	131	170	229	156	87	920	176	32	417	76	121	132	77		290
300<=X<310	31	67	57	119	187	290	363	244	137	221	314	67	211	320	272	365	279	116	127	344	63	467	753	863	333	106		76
310<=X<320	32	391	342	3	139	305	263	316	106	232	300	131	320	340	316	329	279	220	75	307	226	141	457	349	356	761		26
320<=X<330	33	184	37	1	72	284	64	233	160	219	237	230	262	161	248	217	198	260	39	194	465	30	320	234	184	630		7
330<=X<340	34	7	37		61	38	19	109	73	129	161	297	141	12	94	94	97	261	27	48	364	17	65	106	59	296		1
340<=X<350	35	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		9
350<=X<360	36	6	3		22	1		6	1	71	10	99	12	11	10	71	29	70	97	9	19	8	10	21	16	[illegible]		7
		187	820	1	100	611	778	3101	233	83	251	4	188	159	610	371	994	561	617		136	599	208	129	313		46727	

Figure 5. Editing Output Illustrating the Frequency Distribution of One-Minute Average Wind Directions for all Mesonetwork Stations in 10° Wind Direction Categories for the Period 2240 GMT, January 20 Through 1333 GMT, January 24, 1973

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		HMP	ANS	PLH	HAV	LAW	STO	NTP	DSK	TAG	THK	MTN	AVC	HAC	BIL	CHS	CCG	VAH	MTR	NKF	RKO	HRY	VRY	ERY	ONF	OPN	TML	THH
0.0<=X< .3	1	820	1		168	611	278	3101	233	83	251	4	188	159	610	371	996	561	617		136	599	208	129	313		46727	
.3<=X<1.0	2	274	2		179	37	279	41	96	69	447	21	70	497	290	377	370	777	770	76	259	170	261	269	189	794	76	2241
1.0<=X< 2	3	948	27	39	865	231	446	187	40	140	627	40	529	676	664	633	680	608	348	121	418	293	413	303	141	601	21	206
2<=X< 3	4	961	706	174	874	916	619	290	118	187	626	122	991	475	821	971	836	717	480	636	834	421	617	614	590	575	25	4
3<=X< 4	5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	743	[illegible]	[illegible]	[illegible]	[illegible]	718	[illegible]	[illegible]	[illegible]	[illegible]	610	40	21
4<=X< 5	6	335	670	929	860	581	641	467	344	850	561	996	630	444	364	396	393	497	400	739	501	416	675	929	574	526	26	62
5<=X< 7	7	525	1609	925	826	649	650	811	953	1796	547	1521	676	664	368	406	282	919	621	827	929	761	672	788	808	761	38	512
7<=X< 9	8	456	985	700	345	317	377	796	893	993	239	464	257	371	714	718	156	317	798	629	774	821	117	385	458	475	13	653
9<=X< 11	9	369	361	989	140	158	176	518	784	321	170	342	120	109	188	140	76	233	130	244	196	236	218	165	183	209	16	362
11<=X< 13	10	165	196	764	97	116	130	309	89	387	139	253	102	111	147	137	96	129	104	120	174	177	136	115	161	199	2	165
13<=X< 15	11	[illegible]	[illegible]	104	[illegible]	119	[illegible]	228	[illegible]	282	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	133	102	140	[illegible]	121	124	128	152	3	127
15<=X< 18	12	2	79	171	10	101	57	173	20	167	76	103	35	144	98	41	2	61	105	174	169	159	198	105	119	169	1	130
18<=X< 21	13	1	36	159		97	10	56	17	56	11	36	3	199	26	9	1	17	98	121	73	162	178	118	38	76	2	14
21<=X< 24	14	1	6	136		30	7	3	9	17	3	0	1	87	6	7		2	51	69	17	104	49	31	7	16		5
24<=X< 27	15			159		4			4	4		3		47	1	2			8	23	7	61	26	8	1	6		1
27<=X< 30	16			74		1			7			7		25	1					9		13	5					
30<=X< 35	17			34		3			1					2						2								1
35<=X< 40	18			7					1																			
40<=X< 45	19																											
45<=X< 50	20																											
50<=X< 55	21																											
55<=X< 60	22																											
60<=X< 65	23																											
65<=X< 70	24																											
70<=X< 75	25																											
75<=X< 80	26																											
80<=X< 85	27																											
85<=X< 90	28																											
90<=X< 95	29																											
95<=X<100	30																											

Figure 6. Editing Output Illustrating the Frequency Distribution of One-Minute Average Wind Speeds (knots) for all the Mesonetwork Stations for the Same Period Noted in Figure 5

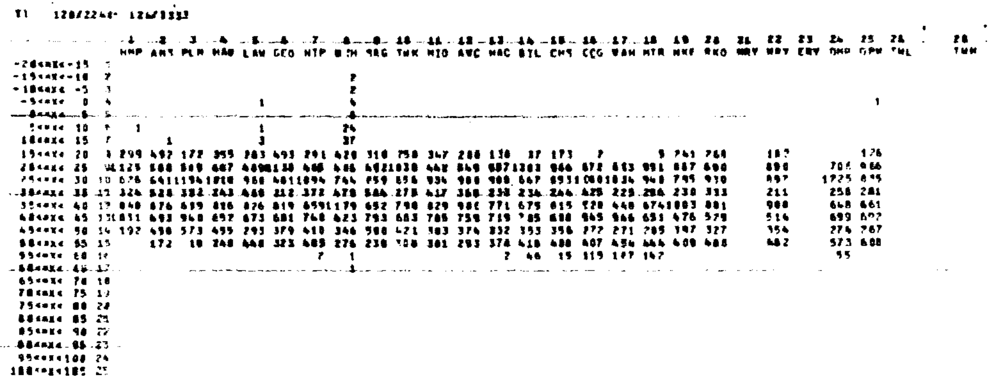

Figure 7. Editing Output Illustrating the Frequency Distribution of One-Minute Average Temperatures (^oF) for all the Mesonetwork Stations for the Period Noted in Figure 5

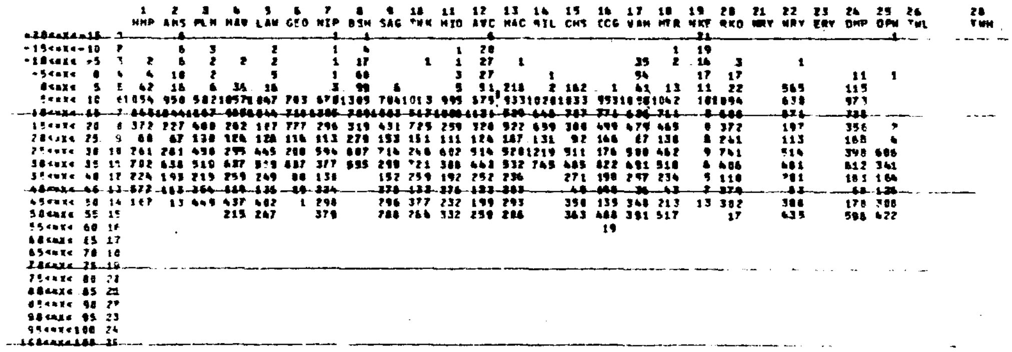

Figure 8. Editing Output Illustrating the Frequency Distribution of One-Minute Average Dewpoints (^oF) for all the Mesonetwork Stations for the Period as in Figure 5

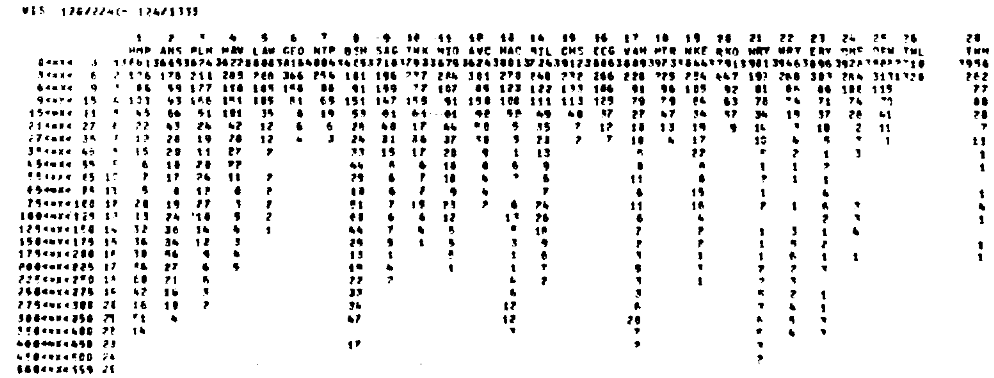

Figure 9. Editing Output Illustrating the Frequency Distribution of One-Minute Average Extinction Coefficients ($x10^{-4}m^{-1}$) for all the Mesonetwork Stations for the Same Period as in Figure 5

In the case of wind direction, Figure 5, one-minute average values are categorized in 10^{o} intervals. The bottom line, 37, contains the frequency count of calm conditions. Scanning this table provides additional insight into an examination of the consistency and validity of the wind-direction sensors. For example, Station 2-A shows an unusually high, and unrealistic, count of wind-direction occurrences between 10 and 20^{o}, 110 and 120^{o}, and 310 and 330^{o}. This lends support to the discrepancy noted in Figure 4 for the same station, and gives further justification to the determination that the wind-direction sensor was malfunctioning. The same rationale is used to suppress the data for station 18-MTR, which shows an unrealistic number of occurrences in the 1 to 10^{o} wind-direction range, Station 28-TWH, which has too high a count in the 230 to 240^{o} range, and, finally, Station 26-TWL, which shows most winds were calm.

Figure 6 shows the frequency distribution of one-minute average wind speeds for each station. The rows are identified with the appropriate wind-speed categories (knots) while the columns are titled with each station number and call letter. A scan of the frequency distributions shows a physically consistent shift to higher speeds at the hilltop, tower, and coastal locations (2-AMS, 3-PLM, 11-MID, 19-NKE, and 28-TWH). The very large number of calms at station 26-TWL also verifies the malfunctioning of that sensor.

The frequency distribution of one-minute temperature values is shown in Figure 7. The caption in the upper left denotes the time interval included in this tape, January 20, 2240 GMT to January 24, 1333 GMT. The columns are labeled with station number and call letters, while the rows give the temperature categories (^{o}F). It is apparent that several of the stations (1, 2, 5, and 25) have reported several observations that are out of normal range, and do not appear valid. A later figure, Figure 10, will show how these individual readings are catalogued and identified for editing. The temperature set at Station 8-BSH appears to have a major problem and is a candidate for complete deletion.

Figure 8 shows the frequency distribution of one-minute average dewpoint values. Columns and rows are the same as in Figure 7. The dewpoint sensors appear to generate noisier data than the temperature sensors. Stations that are candidates for elimination because of malfunctioning sensors are 2, 8, 12, 17, and 19. The remainder of the stations can be retained after editing out the individual minutes that lie outside the expected ranges.

The one-minute average values of extinction coefficient, Figure 9, are the most difficult to edit. The range of the visibility values from $0 \times 10^{-4} m^{-1}$ to $500 \times 10^{-4} m^{-1}$, when combined with the sometimes local nature of visibility restrictions, allows for wide variations between stations. At the same time, some visibility restrictions have very short lifetimes. We have found that examination of the time variation of visibility at a single location (see Figure 3) provides the best means for determining the validity of a forward-scatter-meter's measurements. It should be noted that this frequency distribution, Figure 9, represents data that was collected between January 20, 2240 GMT, and January 24, 1333 GMT. Re-examination of the daily records for each station showed that on January 23 high extinction coefficients were recorded for a short period of time at most of the stations.

Figure 10 is a representative section of the last output of the editing program. This section of the program lists, chronologically and by station, those one-minute

					TT	TD	WS
WDSP OUT OF RANGE	73	1202240	CHS	15			212
WDSP OUT OF RANGE	73	1202242	LAW	5			249
WDSP OUT OF RANGE	73	1202244	HIP	11			246
WDSP OUT OF RANGE	73	1202251	FRY	23			241
WDSP OUT OF RANGE	73	1202255	PAC	8			244
WDSP OUT OF RANGE	73	1202301	HTP	18			251
WDSP OUT OF RANGE	73	1202303	AVC	12			145
DWPT OUT OF RANGE	73	12023[illegible]	PLM	[illegible]		1	
DWPT OUT OF RANGE	73	1202307	PLM	3		-37	
DWPT OUT OF RANGE	73	1202308	PLM	[illegible]		19	
WDSP OUT OF RANGE	73	1202308	HTP	18			262
WDSP OUT OF RANGE	73	1202329	DPW	25			240
WDSP OUT OF RANGE	73	1202330	FRY	23			247
WDSP OUT OF RANGE	73	1202331	PMP	24			211
WDSP OUT OF RANGE	73	1202332	ASH	4			219
WDSP OUT OF RANGE	73	1202334	HKF	19			222
WDSP OUT OF RANGE	73	1202339	HIP	7			236
TEMP OUT OF RANGE	73	1202348	LAW	5	-11		
WDSP OUT OF RANGE	73	1202351	BVT	12			228
WDSP OUT OF RANGE	73	1202357	HKF	19			271
TEMP OUT OF RANGE	73	1202358	ASH	4	17		
WDSP OUT OF RANGE	73	1202359	POW	25			267
TEMP OUT OF RANGE	73	121 [illegible]	LAW	5	110		
WDSP OUT OF RANGE	73	121 2	CEO	6			151
WDSP OUT OF RANGE	73	121 11	HKF	19			271
WDSP OUT OF RANGE	73	121 15	CEO	6			155
TEMP OUT OF RANGE	73	121 15	LAW	5	26		
DWPT OUT OF RANGE	73	121 16	HTR	18		-6	
WDSP OUT OF RANGE	73	121 21	CCG	16			169
WDSP OUT OF RANGE	73	121 24	HIP	7			219
WDSP OUT OF RANGE	73	121 24	POW	25			242
WDSP OUT OF RANGE	73	121 29	TWK	18			211

Figure 10. Editing Output Illustrating the Chronological Listing of Mesonetwork Stations Whose One-Minute Averages of Temperature (TT), Dewpoint (TD), or Wind Speed (WS), lie Outside the Expected Range of Values

values of temperature, dewpoint, and wind speed that occur ten times or less in any of the frequency categories of the three variables. The purpose is to isolate and identify those observations that lie outside the normal range of observations (e.g., see Figure 7, the few outlying temperatures at stations 1, 2, 5, 8, and 25). Two of the variables, wind direction and extinction coefficient, do not lend themselves as readily to this technique. Their values may fluctuate over the full range of measurement during relatively short periods of time. Their erroneous observations, therefore, are not as easily indicated. Referring to Figure 10, the first line of the output shows that a wind speed (WS) of 21.2 knots occurred on January 20, 1973, 2240 GMT, at Station 15-CHS. Examination of the wind-speed frequency output, Figure 6, shows this to be a reasonable, though not frequently occurring, wind speed; therefore, it is not edited out. A quick examination of the wind-speed column (WS) shows that all the wind speeds reported are reasonable and acceptable.

Examination of the temperature column (TT) shows that Station 5-LAW reported a temperature of -1.1°F on January 20, 2348 GMT. Examination of the frequency distribution for this station in Figure 7 shows this value should be edited. Of the remaining three temperature values, two were observed by BSH, and that station temperature sensor data has already been completely eliminated (see discussion of Figure 7). The final temperature, which is out of range in this example, is the report by station 5-LAW of 11.8°F on January 21, 1973, 0026 GMT. Examination of the LAW frequency distribution in Figure 7 shows this may be an acceptable reading. Further examination of the individual hourly records of this station, however, revealed this value to be well outside the normal range of temperatures reported during that hour; therefore, it was deleted.

Finally, the dewpoint column shows that Station 3-PLM observed three widely varying values of 0.3-3.7, and 3.9°F within a three-minute period. Such a variation is not reasonable and therefore it was edited out. The last dewpoint value of -6.5°F observed by Station 18-MTR on January 21, 0016 GMT, also provide, upon examination of Figure 8, to be well outside the expected range of values and, therefore, it was edited out.

5. CLIMATOLOGY OF THE MESONETWORK

The term climatology, as used here, denotes the study of meteorological variables with respect to their dependence on geographical location within a mesoscale-sized area. The variables specifically analyzed in this study are atmospheric extinction coefficient, wind speed, and wind direction. The geographical location is, of course, the Hanscom Air Force Base area and its surroundings.

5.1 Data Base

The unedited data base collected by the AFGL Mesonetwork during the four years of operation consisted of 420 magnetic tapes. In this initial effort, 111 of the tapes representing the one-year period from September 1972 through August 1973, have been edited. Data (temperature, dewpoint, visibility, wind direction, and speed) for all stations, were edited and stored on 16 master magnetic tapes in the form of one-minute averages. Editing of the remaining magnetic tapes will continue.

Major emphasis was placed on obtaining a data base to develop and test mesoscale probability forecast models and to serve in specification studies.

Thirteen of the stations were selected, based on geographical and topographical considerations, to illustrate the visibility and wind variations that occurred on the mesoscale during the first year of data collection. The climatological tables

(Volume II, Sections 2 through 6) have been constructed using the Air Weather Service ETAC Revised Uniform Weather Summary[10] (RUSSWO) format as a model.

5.2 Hours of Operation

Table 2 shows the number of hours of operation, by month, during the first year of network operations for the wind and visibility sensors at each of the selected

Table 2. Hours of Operation of the Wind Sets and Forward-Scatter-Meters at Selected Stations in the AFGL Mesonetwork from September 1972 Through August 1973

STATION/SENSOR		1972 SEP	OCT	NOV	DEC	1973 JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG
3	WIND	416	449	0	273	313	416	477	614	706	674	603	445
PLM	VSBY	446	466	295	536	426	497	516	633	707	674	605	445
7	WIND	77	461	226	560	476	466	472	667	668	514	605	440
NIP	VSBY	451	461	533	601	476	548	486	667	668	669	605	449
8	WIND	452	389	401	550	281	290	487	646	711	685	427	453
BSH	VSBY	447	394	479	653	328	371	489	658	711	685	632	453
9	WIND	433	462	273	496	475	527	457	657	708	685	633	453
SAG	VSBY	0	446	536	664	475	546	520	658	708	685	633	453
10	WIND	0	81	536	629	480	538	520	506	704	681	632	453
TWK	VSBY	449	90	530	664	480	537	520	506	704	681	597	453
13	WIND	452	465	219	581	349	453	520	667	712	682	664	449
HAC	VSBY	318	465	536	664	349	466	520	667	712	682	664	449
15	WIND	452	465	509	627	452	525	520	667	712	684	665	449
CHS	VSBY	447	465	535	664	452	528	520	667	712	684	560	449
20	WIND	335	464	536	535	407	440	520	667	712	682	664	448
RKO	VSBY	446	187	536	664	408	501	520	667	712	682	666	448
21	WIND	95	0	96	526	480	548	445	250	633	692	672	453
NRY	VSBY	327	81	536	667	480	548	520	667	712	692	666	452
22	WIND	260	458	438	629	475	532	520	667	148	0	0	0
WRY	VSBY	449	466	536	666	475	532	520	667	702	0	160	0
23	WIND	260	465	533	667	480	544	520	667	640	625	666	441
ERY	VSBY	350	465	534	667	480	544	520	667	638	626	652	451
26	WIND	0	0	0	0	0	26	486	534	669	667	433	433
TWL	VSBY	0	0	0	0	0	0	480	579	669	667	605	449
28	WIND	0	0	0	0	134	467	520	667	707	677	605	451
TWH	VSBY	393	461	533	575	432	548	520	667	707	677	605	451

stations. In the editing process, an hour of data was accepted if more than 30 minutes of observations were available during that hour. During the first few months of operation, some of the stations were not completely equipped with sensors. For example, the lower level of the tower (TWL) was not completely equipped until March 1973, and the upper level of the tower (TWH) was delayed until January 1973. Data retrieval problems reduced the number of observations from the WRY site during the latter part of 1973. As was expected, the winter months

10. Revised Uniform Summary of Surface Weather Observations (RUSSWO) Part C and D, Station - Bedford, Massachusetts - Air Force Environmental Technical Application Center, Scott AFB, Illinois.

show a lower number of operations hours because of weather-related problems, and the difficulties in maintenance following instrument malfunction. The wind sets, in particular, experienced some freezing problems during the first winter of operation. This was essentially eliminated in the following years with the installation of heating cables around the base of each sensor during the summer of 1973.

5.3 Visibility Variation

As mentioned in an earlier section, visibility measurements in the Hanscom Mesonetwork were obtained using a forward-scatter-meter. This meter measures light scattered in a forward direction that is directly related to the atmospheric extinction coefficient (EXCO). The EXCO will be used in this and subsequent sections (Volume II, Sections 2 and 3) in lieu of visibility. EXCO values can easily be converted to day or night visibilities using Koschmieder's or Allard's Laws.[11]

5.3.1 ANNUAL

Figure 11 is a cumulative frequency graph of EXCO of selected stations for the one-year period of the study (See Appendix B for monthly data for all thirteen stations). For reference, EXCO readings of $20 \times 10^{-4} m^{-1}$, $40 \times 10^{-4} m^{-1}$, and $80 \times 10^{-4} m^{-1}$ represent daytime visibilities of about 1450, 725, and 360 meters, respectively.

The mesonetwork stations depicted on the graph are hill sites (BSH and SAG), coastal sites (PLM and NIP), a swamp site (HAC), a valley site (TWK), a 45 m elevation tower site (TWH), and a runway site (NRY). The final curve on the graph (BED) represents the values of EXCO frequency for Hanscom Air Force Base that were extracted from the visibility tables of the Hanscom RUSSWO[11] and converted using Koschmeider's equation. The graph clearly ranks the sites on the basis of location. The hill sites have the highest frequencies of occurrence, followed by the coastal sites. The tower site (TWH) ranks next and reinforces the significance of height above ground on frequencies of restrictive visibility. The remaining swamp, valley, and runway sites rank in that order but are of similar magnitude. None of these three sites could be categorized by a single descriptive term. Instead, each showed some of the characteristics of the others. Finally, it is interesting to note the similarity of the frequencies observed by NRY and by BED. On the one hand, the NRY curve represents one-minute average EXCO values over

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11. Middleton, W. E. N. (1952) Vision through the Atmosphere, University of Toronto Press, Chapter 10, pp. 215-225.

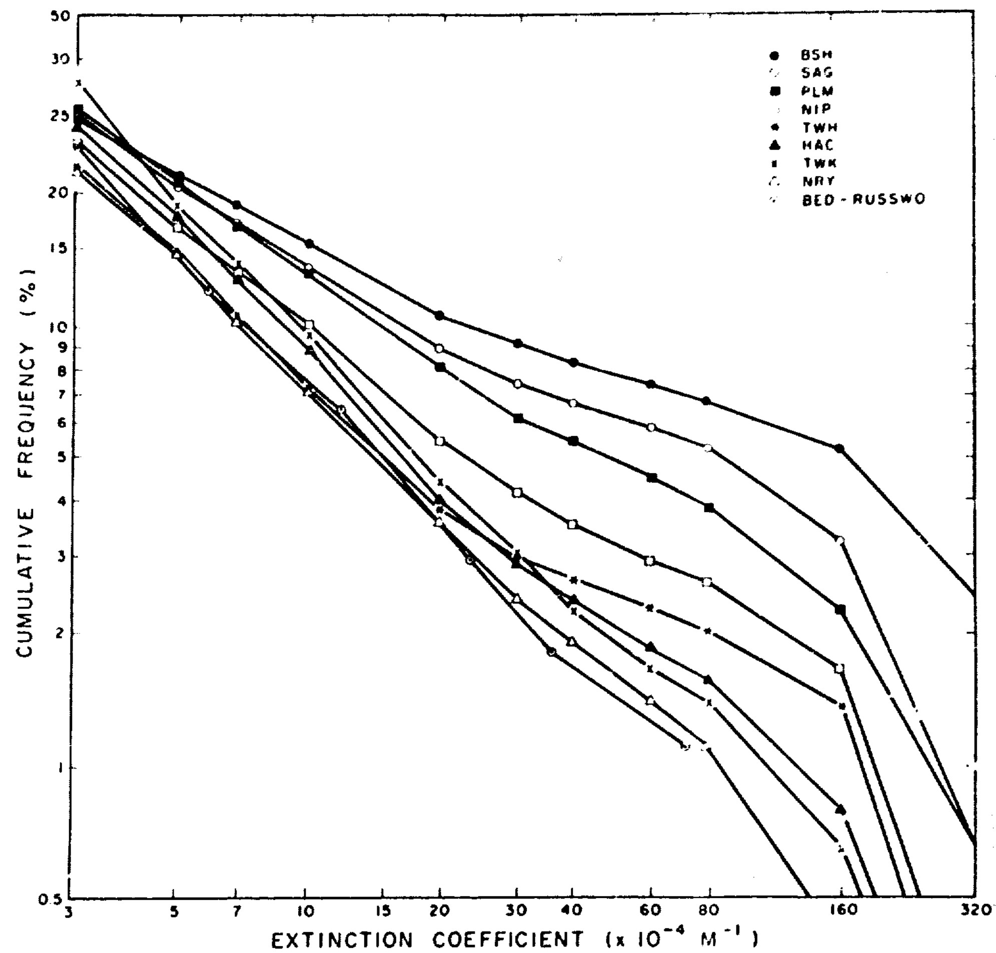


Figure 11. Cumulative Frequency Distribution of Extinction Coefficient at Eight Representative Stations in the AFGL Mesonetwork During the Period September 1972 through August 1973.

the relatively short period of one year. On the other hand, the BED curve was based on one-hourly observations collected over a twenty-five-year period. It gives some assurance that the one-year data set was not significantly different from the long-term climatology, at least as represented by visibility.

5.3.2 DIURNAL

Figures 12 a-d show the diurnal percent frequency distribution of EXCO at four sites representative of the geographical/topographic variation within the mesonetwork. The curves illustrate the frequency of occurrence of EXCO observations that equaled or exceeded $20 \times 10^{-4} m^{-1}$ (extracted from Volume II, Section 3). Four months (September, December, March, and June) were selected

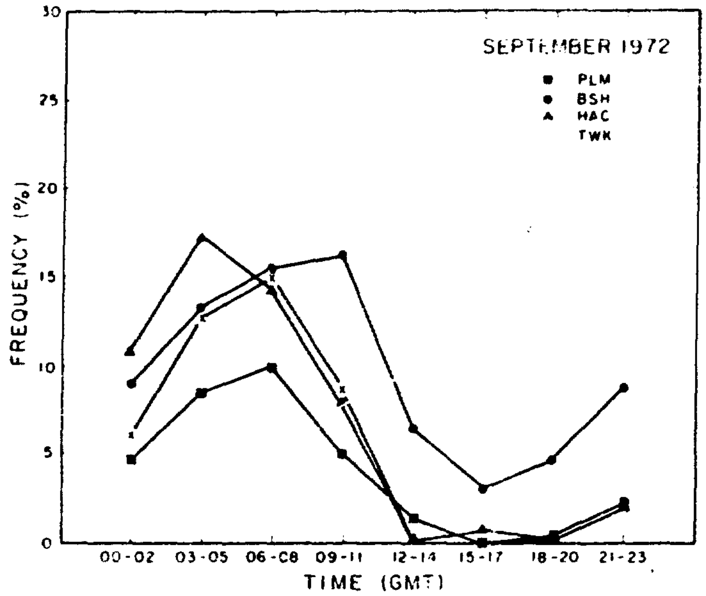


Figure 12a. Frequency Distribution of Extinction Coefficient Equal to or Greater Than $20 \times 10^{-4} m^{-1}$ Versus Time (GMT) of Day at Four Representative Sites for the Month of September 1972

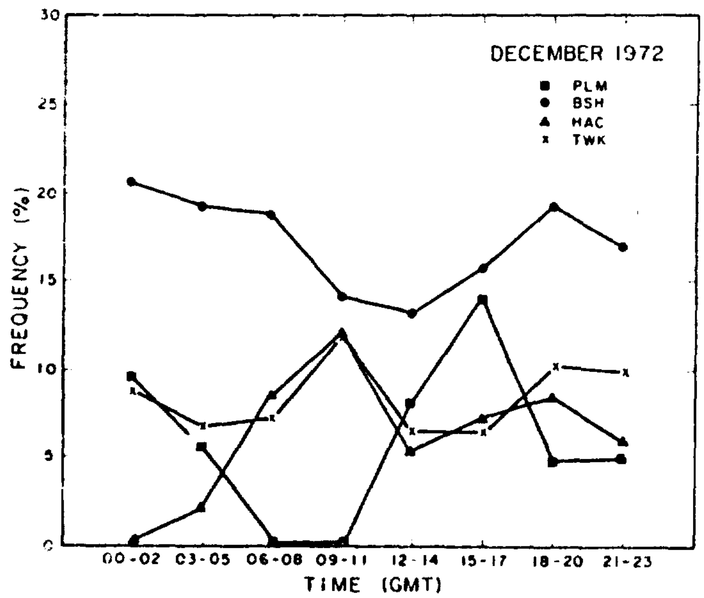


Figure 12b. Frequency Distribution of Extinction Coefficient Equal to or Greater than $20 \times 10^{-4} m^{-1}$ Versus Time (GMT) of Day at Four Representative Sites for the Month of December 1972

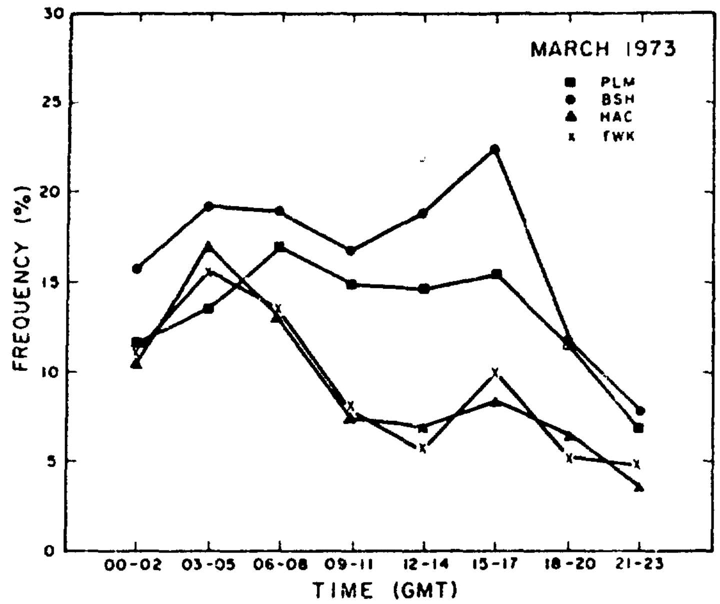


Figure 12c. Frequency Distribution of Extinction Coefficient Equal to or Greater Than $20x10^{-4}m^{-1}$ Versus Time (GMT) of Day at Four Representative Sites for the Month of March 1973

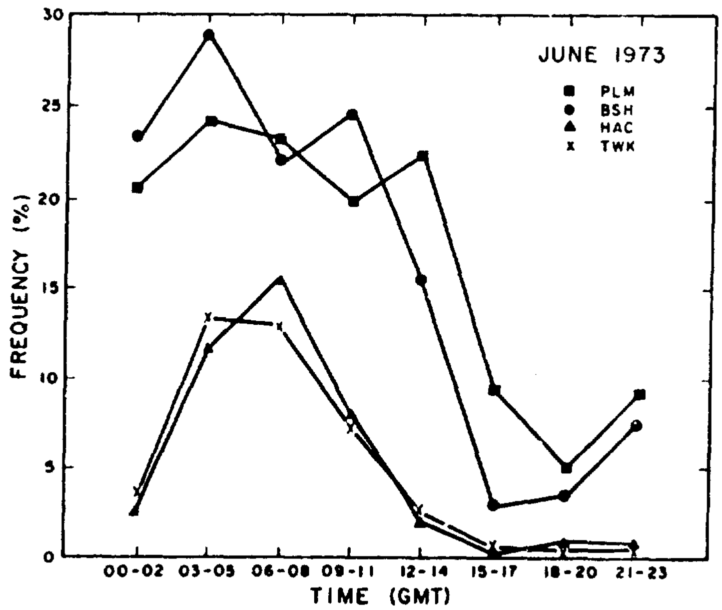


Figure 12d. Frequency Distribution of Extinction Coefficient Equal to or Greater Than $20x10^{-4}m^{-1}$ Versus Time (GMT) of Day at Four Representative Sites for the Month of June 1973

to illustrate the seasonal variation. The percentages were computed with respect to a specific time category; example, 16 percent occurrence within the time period 0300 GMT to 0600 GMT, relative to the total observations occurring in that time interval only.

During the month of September 1972, Figure 12a, all stations show a pronounced diurnal variation of EXCO with a nocturnal maximum. The swamp and valley sites, HAC and TWK, show higher frequencies at night, which is attributable to the increased number of radiation fog occurrences during the fall. BSH, a hill site, has a higher overall frequency of lower visibility that reflects the effects of low clouds intercepting hilltops, especially closer to the coast, while PLM, a low coastal site, shows the moderating influence of the ocean on radiative log occurrence.

The winter month, Figure 12b, gives a chaotic appearance with no pronounced diurnal effects. The high frequency of occurrence throughout the day at BSH, the hill site, is probably due to the effect of traveling winter storms that produce low clouds and visibilities, irrespective of the time of day. The remaining stations have lower frequencies of high EXCOs and show no consistent diurnal pattern.

The spring month, Figure 12c, shows a gradual return to a diurnal variation of EXCO at the swamp and valley sites, HAC and TWK. The hill and coastal sites, BSH and PLM, on the other hand, continue to exhibit high frequencies of EXCO throughout the day.

During June 1973, Figure 12d, a pronounced diurnal variation was reestablished at all sites. BSH and PLM, the hill and coastal sites, show very high frequencies of occurrence during the night. The inland and low sites also show pronounced nocturnal maxima, but of lower magnitude. These frequencies reflect the large number of coastal advective fogs that predominate along the New England coast during this period of the year, several of which can penetrate well inland.

5.4 Wind-Speed Variation

The wind sets at all stations, except for those located on Hanscom Air Force Base (ERY, WRY, and NRY), were mounted on telephone-type poles at a height of 8 m above ground level. The Hanscom instruments, because of runway safety restrictions, were limited to a height of 4 m. Wind speed is specified in knots in this section and in Volume II, Sections 4, 5, and 6.

5.4.1 ANNUAL

Figure 13 is a cumulative frequency distribution of wind speed at selected stations in the mesonetwork, for the twelve-month data period. Stations were

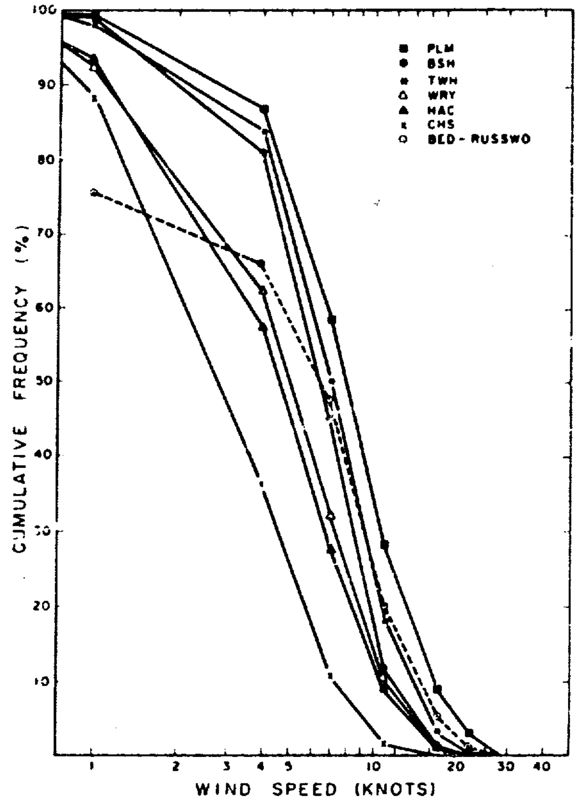


Figure 13. Cumulative Frequency Distribution of Wind Speed at Six Representative Station in the AFGL Mesonetwork During the Period September 1972 through August 1973

selected to represent characteristics of hill tops (BSH), coasts (PLM), swamps (HAC), valleys (CHS), runways (ERY) and towers (TWH). In addition, the RUSSWO[11] data were used to extract the cumulative frequency curve for Hanscom Air Force Base (BED).

The station with the greatest frequency of wind speeds equal to or greater than 11 knots is PLM, a coastal site. Next in rank are two stations where height plays the major role, TWH (45 m level on tower) and BSH (hilltop site). The remaining stations, in descending order, are the ERY (a runway site, similar to a valley), HAC (a swamp site with relatively open exposure), and CHS (a valley site with significant surrounding topographical features).

The BED curve is of considerable interest because, at the higher speeds, it more nearly resembles the tower curve at Bedford (TWH) than the surface runway site (ERY). There could be several explanations to account for this; example, the operational and mesonetwork wind sets were different and, in fact, the high start speed of the operational wind sets accounts for the sharp drop in wind-speed frequency below four knots. In addition, we are comparing a long-term climatology (BED) with a one-year sample (TWH and ERY). At the same time, we are comparing statistics generated by the one-minute, minute-to-minute wind-speed averages of the mesonetwork (ERY, TWH) with one-minute wind speed recorded on an hourly-observation cycle at BED. Examination of the RUSSWO also indicates that the wind observations for a nine-year period of time at BED were taken from a set mounted on the top of a hangar (70 ft) or the weather station building (37 ft). Prior to that, the location of the wind set was not specified for a ten-year period. Thus, the BED frequency curve more nearly exhibits the characteristics of a sensor mounted at a substantial height above the ground.

5.4.2 DIURNAL VARIATION

Figures 14A-D were constructed to examine the diurnal variation of wind speed during each season at mesonetwork stations selected to represent coastal, hilltop, valley, and swampy locations. Frequencies for all wind speed equal to or greater than 11 knots were extracted from Volume II, Section 5.

A pronounced diurnal variation of speed occurred at all stations in each season. PLM, the coastal site, had the highest frequencies of winds over 11 knots for all four seasons. The greatest frequency of high winds occurred during March at the hill (BSH), swamp (HAC), and valley (CHS) sites. The greatest frequency of high winds at the coastal site (PLM), however, occurred during December. This figure reaffirms the results seen in Figure 13, that the coastal, hill, swamp, and valley sites rank in that order of high wind-speed frequency.

5.4.3 TOPOGRAPHIC EFFECTS ON HANSCOM AIR FORCE BASE WIND SPEED

Measurements of surface wind speed and direction were made at three locations at Hanscom Air Force Base, Figure 1. The topography of each site, seen in Appendix A, denotes significant topographical features that surround the field. The WRY site is located just to the east of Pine Hill, which rises 33 m above the runway level. Although not shown on the topographical chart, the NRY site was located to the southwest of a densely wooded area. Consequently, winds from the northeast could be affected. In addition, hills are located to the northwest and southeast of the station. The ERY site, on the other hand, was situated just north of a major obstruction, Kahtahdin Hill. To the east and northeast of the ERY site are dense forests, with another hill further to the east northeast.

To validate the effects of the topographic features on the runway winds, the bivariate percentage frequency distributions, listed in Volume II, Section 6, were examined for the three sites. Figure 15 depicts the distribution for April 1973, a month that shows the topographic effect most clearly because of the high frequency

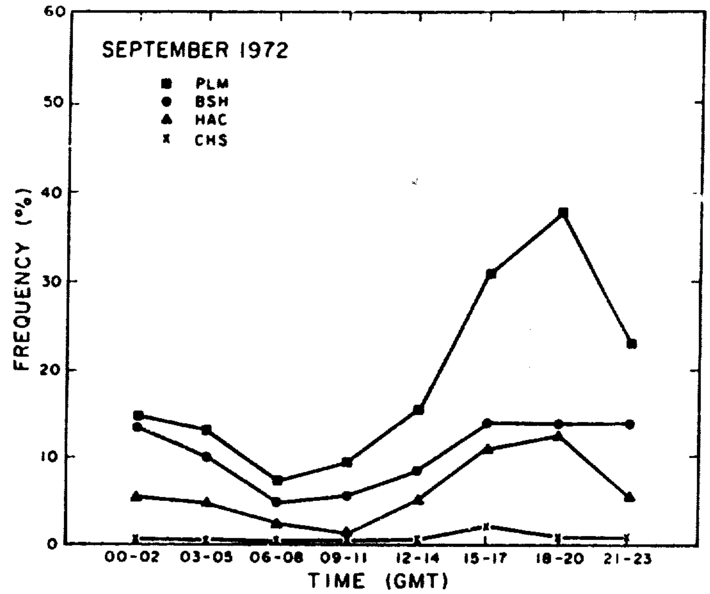


Figure 14a. Frequency Distribution of Wind Speed Equal to or Greater than 11 Knots Versus Time of Day at Four Representative Sites for the Month of September 1972

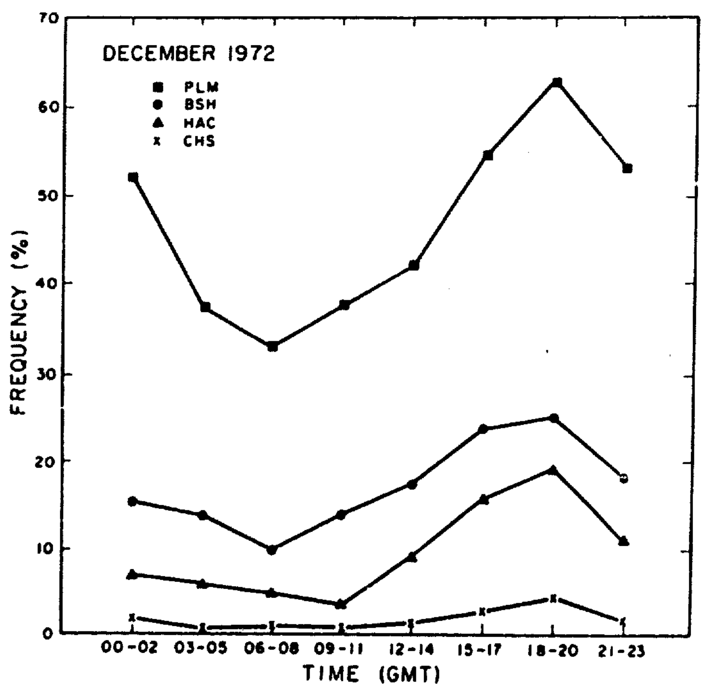


Figure 14b. Frequency Distribution of Wind Speed Equal to or Greater than 11 Knots Versus Time of Day at Four Representative Sites for the Month of December 1972

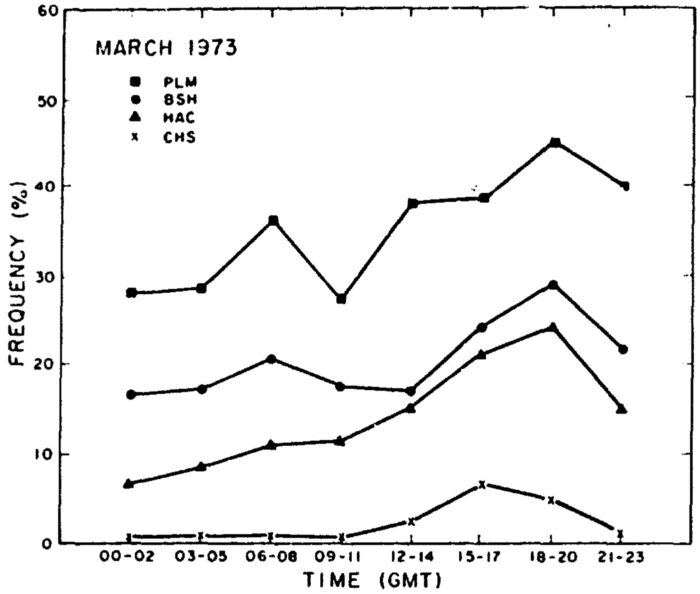


Figure 14c. Frequency Distribution of Wind Speed Equal to or Greater than 11 Knots Versus Time of Day at Four Representative Sites for the Month of March 1973

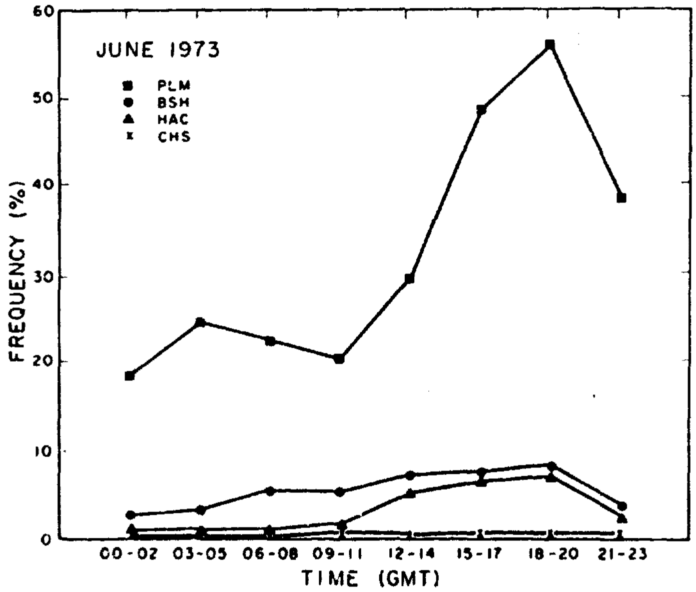


Figure 14d. Frequency Distribution of Wind Speed Equal to or Greater than 11 Knots Versus Time of Day at Four Representative Sites for the Month of June 1973

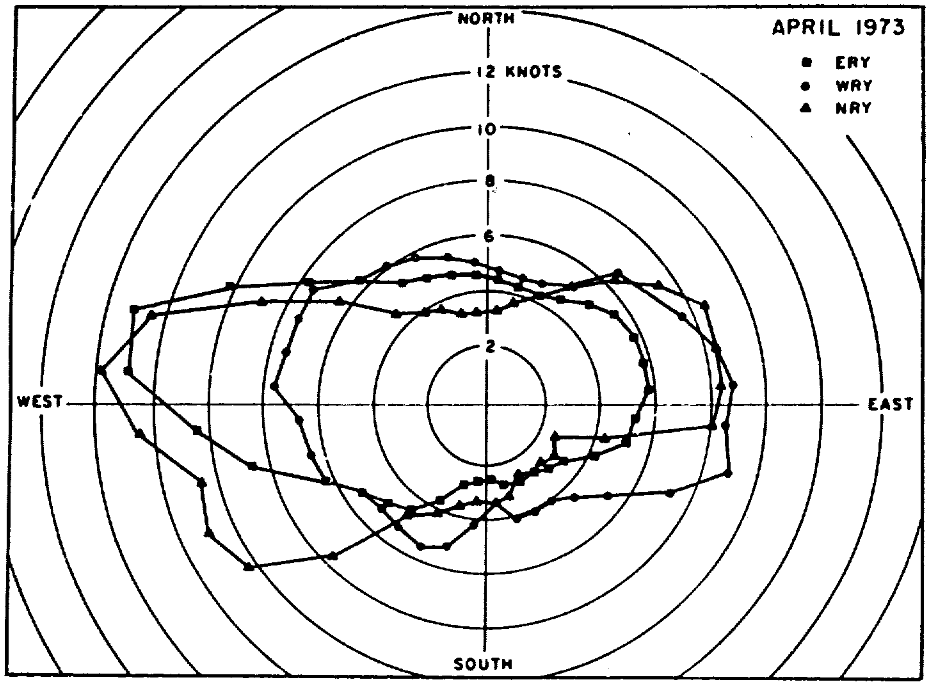


Figure 15. Distribution of Average Wind Speed as a Function of 10-Degree Direction Intervals During the Month of April 1973 for Three Stations Located Along the Principal Runway at Hanscom Air Force Base, Massachusetts

of strong east and west winds during the month. For west-wind occurrences, the NRY and ERY have a long unobstructed fetch across the airfield, and appreciably stronger winds were observed than at the WRY, located in the shadow of Pine Hill. Conversely, for easterly winds, the WRY and NRY reported stronger winds than the ERY, because they experience unobstructed flow during east winds. Consistent with other topographic features, the ERY reports lower southerly wind speeds than the other two stations, and the NRY reports lower wind speeds from the north than the ERY and WRY.

6. SUMMARY

The results of the climatological survey can be summarized as follows:

(i) An editing program for the AFGL Mesonetwork has been written, tested, and utilized in editing 12 months (111 tapes) of data between September 1972 and August 1973. The edited data (temperature, dewpoint, wind direction and speed, and visibility) for the twenty-six station network have been compacted and stored on sixteen magnetic tapes in the form of one-minute averages.

(ii) Edited hard-copy output for each of the 111 tapes has been generated in the form of one-hour averages of the variables (Figure 3); daily averages (Figure 4); and frequency distributions of wind direction (Figure 5), wind speed (Figure 6), temperature (Figure 7), dewpoint (Figure 8), and visibility (Figure 9).

(iii) Topographic charts were constructed for each of the mesonetwork stations to show the location of features that could have a significant local effect on the data.

(iv) A twelve-month climatological survey was conducted with thirteen of the stations of the mesonetwork. Selection was based on topographic features or geographic location in the network. The representation included two tower sites (TWL and TWH); three runway sites (NRY, ERY, WRY); two swamp sites (HAC and RKO); two valley sites (CHS and TWK); two hill sites (BSH and SAG); and, finally, two coastal sites (NIP and PLM). The survey was limited to extinction coefficient (visibility) and wind direction and wind speed.

(v) Cumulative frequency curves for the twelve-month study ranked the stations according to frequency of visibility restrictions. The highest frequencies were observed by the hill sites, and decreased in frequency to the coastal sites, the runway sites, and to the lowest frequencies at the valley sites. Comparison of the Hanscom Air Force Base mesonet data (NRY) with the Hanscom Air Force Base RUSSWO data (BED) indicated the twelve-month period was close to the long-term climatology for visibilities.

(vi) Diurnal variation of extinction coefficient throughout four months representative of the four seasons were graphed. They showed strong diurnal variation with nocturnal maxima in fall and summer, and no pronounced dirunal effect in winter and spring. The effects of coastal fog in June on the network was quite apparent.

(vii) Frequency curves of wind speed for selected stations for the twelve-month period clearly specified the coastal and hill sites as having the highest frequencies of high winds. Due mainly to sheltering effects of surrounding topography, the valley site showed the lowest frequencies.

(viii) Diurnal variations of wind speeds were graphed for four months representative of the seasons. Strong diurnal variation was apparent for all seasons.

(ix) A comparison of three stations located along the runway at Hanscom Air Force Base, during the month of April 1973, revealed the effects of surrounding topography on the surface wind speeds. Significant shadowing of wind speeds occurred on the lee sides of hills and forests.

This initial mesoclimatology analysis considered three variables at thirteen stations for a period of one year (September 1972 through August 1973). Extension to the remaining stations, variables, and years two, three, and four of the full sample is continuing. In the meantime, the edited one-year data base is being used in the development of short-range forecasting techniques, and in time and space variability and specification studies.

Appendix A

Topographic Charts

Topographical charts for each mesonetwork station have been prepared together with descriptive comments on each station. Each chart covers an area of 1.8 km x 1.8 km and contours are drawn for every 20 ft. While the analysis described in this report was limited to 13 of the stations, edited and processed data for all 31 locations listed in this Appendix are available on magnetic tape for further study.

1. HMP - 2 m

The site at Hampton, New Hampshire was the lowest in elevation of any site in the network. The sensors were located within 5 m of the edge of the tidal flats that separated the mainland from the barrier island further to the east. Exposure to the east and south was excellent. Some trees were located to the north and west.

1A. DEV - 79 m

This site was situated at Ft. Devens, Massachusetts on a small plateau that was open, quite flat, and relatively free of trees. To the east, a rather abrupt drop in height occurs to a valley that contains the Nashua River.

2. AMS - 87 m

The site at Haverhill, Massachusetts was just below the crest of Powwow Hill (101 m) and located on its southeast face. This side of the hill had been cleared of trees, and the exposure to the north, east, and south was excellent. Nearby water bodies are Lake Gardner to the west, and the Merrimack River, 2.5 km to the south.

2A. MIL - 84 m

This site was located just north of the Town of Milford, Massachusetts on a relatively flat stretch of land between a range of hills to the east, and Cedar Swamp Pond to the west. The surrounding area was being utilized as a sanitary land fill, and was free of obstructions in all directions. Drainage was from north to south 90°. The remaining three quadrants consisted of open clear fields out to 1 km, and are slightly lower in elevation (40 m) than the tower site. Pine Hill (70 m in height) is located about 1.3 km to the southwest.

3. PLM - 3 m

The site at Plum Island was situated at the northern extremity of the island in an area of sand dunes. Exposure in all directions was excellent. Very little vegetation existed in the area, and topographic features were minor. The northern and western boundaries are the Merrimack River, while the eastern boundary is the Atlantic Ocean.

3A. PLM - 2 m

The original site at Plum Island (3) was relocated when the Coast Guard moved to new quarters. The new mesonetwork location at the Plum Island Airport was 3 km southwest of the first site. Exposure was excellent in all directions.

4. HAV - 49 m

The Haverhill station was located in a region of complex topographic features. Three lakes, Pentucket to the northwest, Saltonstall to the south, and Kenoza to the east, surround the site. Contrasting with the lakes are hills to the north, southeast, and south-southwest. Drainage flow in the vicinity of the site was toward the northeast.

5. LAW - 50 m

The Lawrence site was located at Lawrence Municipal Airport. A small stand of trees was located southwest of the site on a small hill. Exposure of the instruments was very good. The principal topographic features in the vicinity are Osgood Hill (105 m), located 1.2 km to the southeast, and Lake Cochichewick, located just off the end of the southeast runway.

6. GEO - 23 m

The Georgetown site was located on private land just west (60 m) of Interstate Highway 95. The site was on a minor ridge line that extended southwest-northeast. Surface drainage was toward the northeast. The closest trees were about 300 m distant.

7. NIP - 17 m

The North Ipswich, Massachusetts site was located on land leased by AFGL and used as a radio astronomy site. The site was on a slight rise of land that was surrounded by saltwater marshes. The only significant feature within a mile of the site was a band of trees oriented east-west along the 20-ft contour to the north of the station.

8. BSH - 114 m

Boston Hill, located in North Andover, Massachusetts was one of the principal hilltop sites in the mesonetwork. It was also one of the most completely instrumented sites with temperature, dewpoint, forward-scatter-meter, rain gauge, wind direction and speed, and transmissometer. The top of the hill had be[illegible] cleared and was being used by Mitre Corporation as an instrument facility. The major obstruction on the hill was a six-story concrete building, formerly used as a radar site. This building was located 76 m south of the mesonet site. Drainage at the site was downslope to the north.

9. SAG - 56 m

This station was located on the easternmost peak of Sagamore Hill. Located in the same vicinity was the 18-m solar telescope operated by AFGL. This was located just to the west of the mesonet station site. The top of the hill had been cleared of trees; however, the lower elevation was still densely forested. This site, along with BSH (Boston Hill), was one of our four major hilltop locations. The surrounding hills, Eveleth to the south, Willow to the north-northeast, and Sagamore to the west, reach heights of 59, 54, and 57 m, respectively.

10. TWK - 35 m

This station was located on open flat terrain just northeast of a hill that was approximately 53 m in height. Situated directly to the east at about 300 m was a grove of oak and pine trees that were about 10 m in height. A complex of brooks combines just to the northwest, proceeds east, and then joins Meadow Brook and drains south. Surface drainage flow in the immediate vicinity of the site was toward the southeast.

11. MID - 64 m

The station was located on the northeast slope of a hill that extends to 70 m in height. The area surrounding the site had been cleared and converted to use as farms. Buildings of the Essex County Industrial Farm were also located in the vicinity of the site. Drainage in the immediate location was to the northeast and northwest.

12. AVC - 47 m

This station was located on the southwest side of a hill that extends to 52 m in height. The vegetation had been cleared from the hilltop for the installation of a tower facility by AVCO, Inc. Trees still surrounded the base of the hill in a narrow band, and the area southwest of the site was characterized by low marshy land. Drainage in the vicinity of the site was toward the southwest.

12A. SUD - 64 m

This site was located at the U.S. Military Reservation, Natick Laboratory. It was situated on relatively flat land, between three hills, and was bounded on the north by the Assabet River. Flow along the river was from the southwest to the northeast.

13. HAC - 23 m

This station was located on the southern edge of a marshy plain that bounds the Ipswich River. The site was owned by the Town of Reading and was being used as a water-pumping location. Higher ground lay to the east and southwest of the site, while to the north the land was lower in elevation. Drainage was from the south and west toward the northeast.

14. BIL - 32 m

This station was situated in a cleared area on the grounds of the Shawsheen Regional Technical School. Forests surrounded the cleared area. Drainage in the region was accomplished by the Shawsheen River to the west, and Lubbers Brook to the east. In general, flow was to the north. The only significant hill is to the northeast, which extends to 58 m in height.

15. CHS - 27 m

This station was located about 15 m east of Chestnut Street, on land used by the Town of Wilmington, Massachusetts for water resources. The area surrounding the site was clear of trees to about 300 m. The site itself was situated on the northeast side of a hill which extends in height to 67 m. Drainage within a radius of 1 km was, generally, to the northeast, with the brooks eventually draining into the Ipswich River.

16. CCG - 30 m

This station was located on the grounds of Camp Curtis Guild, a Massachusetts National Guard facility. The land surrounding the site was flat and forested, while the Camp itself was cleared land. The weather site was located at the center of a large open field that was surrounded by small buildings. The site was also situated on the southern end of Center Swamps, about 600 m north of Lake Quannapowitt (elevation 25 m). Drainage was generally toward the east. No significant hills were located within a 1-km radius.

17. VAH - 38 m

This site was located on the grounds of the VA Hospital in Bedford, Massachusetts. The site was characterized by higher ground to the east and west. The valley slopes downward from the north to the south-southeast, and a small spring drains into the Shawsheen River. Wooded areas exist to the northwest, north, and east. The area to the west and southwest was unobstructed. The VA buildings were located about .8 km west of the site.

18. MTR - 38 m

This station was located on a flat open field between Burlington Road (Route 62) and the Mitre Corporation in Bedford, Massachusetts. The station was 40 m north of the road. Higher ground lies to the north and south. The valley is oriented nearly east-west, with drainage to the west. A large complex of buildings (MITRE) was located about 450 m to the north. Several buildings were located on the other side of Burlington Road.

18A. SHR - 165 m

This site was located at the Hill Street Pumping Station in Shrewsbury, Massachusetts. It was located in a valley that was drained by Rawson Hill Brook from west to east. The site was free of trees and was open in all directions.

19. NKE - 49 m

This station was located 3 km northwest of Hanscom AFB at a deactivated NIKE site. The site was a small hill (51 m) surrounded by low (36 m) marshy land that comprises part of the Great Meadows, which bound the Concord River. The river itself lies 1.5 km to the west of the site.

20. RKO - 40 m

This site was located on the southern edge of a swampy drainage area at the site of the Burlington Meadow Street Pumping Station. The northwest and northeast quadrants opened into a large open meadow with low ground and standing water. The southeast and southwest quadrants are predominantly high ground, separated by a drainage brook, which flows from south to north into the meadow.

21. NRY - 38 m

This station was located 245 m north of the central portion of the east-west runway at Hanscom AFB. The northeast quadrant consists of a level wooded area, beginning about 100 m northeast of the site, which slopes gently downward (about 3 m) into a marshy area. The southeast and southwest quadrants were open flat fields containing the runways, and were unobstructed for at least 1 km in all directions. The northwest quadrant contains Hartwell's Hill, located about .8 km from the site, which extends to a height just over 60 m.

22. WRY - 38 m

This station was located within 245 m of the west end of the east-west runway at Hanscom AFB. The northeast and southeast quadrants, extending to 1 km, were open flat fields comprising the remainder of the runways. The main physical feature in the western quadrants was Pine Hill, at a distance of 600 m, which rises about 33 m above the station.

23. ERY - 38 m

This site was located 245 m south of the east end of the east-west runway. The northeast quadrant was characterized by lower land with swampy conditions. Drainage was to the northeast, and formed the headwaters of the Shawsheen River. The southeast and southwest quadrants were dominated by the northern portion of Kahtahdin Hill. The land begins to rise about 200 m south of ERY, and reaches a height of 226 m within 600 m. The northwest quadrant was open flat land, and contained the air-base runways.

24. DMP - 42 m

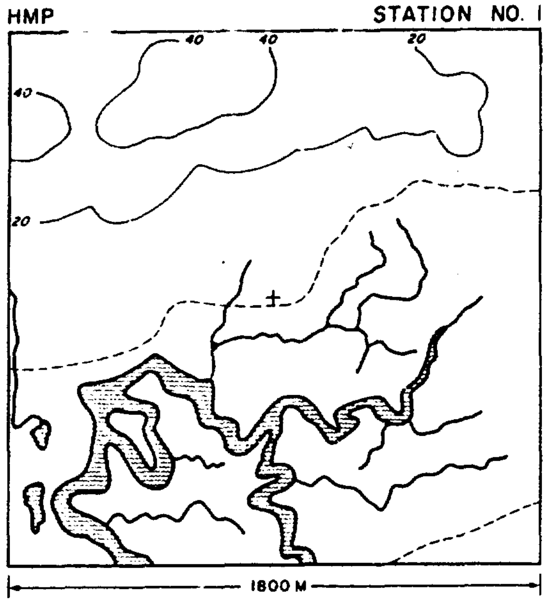
This station was located 670 m from the end of the southwest-northeast runway. The northeast quadrant contained a ridge line extending from northwest to southeast into higher ground (67 m) located in the southeast quadrant. The southwest and northwest quadrants contained land, lower than the site, which was, in general, quite marshy.

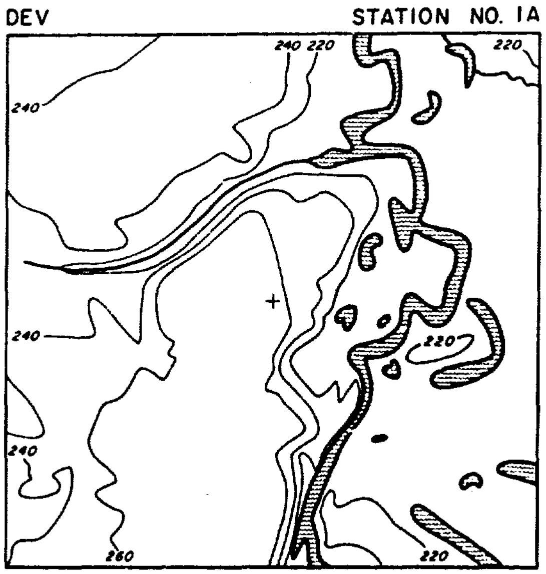
25. DPW - 53 m

This station was located in the southern portion of land used by the Commonwealth of Massachusetts DPW for highway maintenance. It was situated at the intersection of Route 2 and 128. The areas extending 1 km to the northeast and southeast are characterized by the residential areas of Lexington, Massachusetts. The station was surrounded by hills to the north, west, and southwest. Fiske Hill to the north, and Cranberry Hill to the west and southwest, rise to 91 m in height. Drainage was to the south, and the Cambridge Reservoir begins within .8 km.

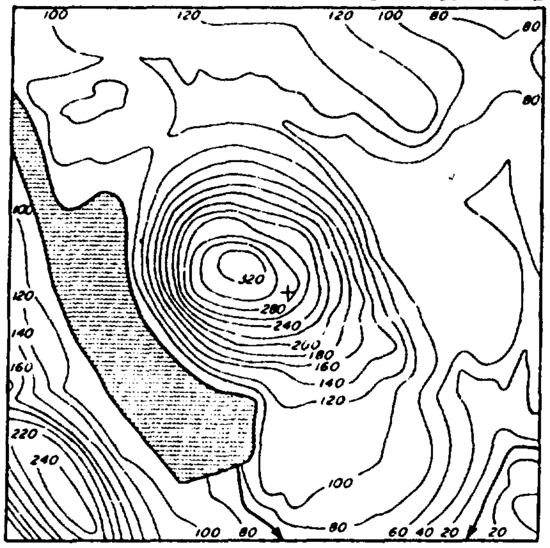
26./28. TWL/TWH - 43 m

The tower site was located 550 m north of the center line of the east-west runway and about 800 m north-northeast of the WRY site. The major topographical feature affecting the tower was Hartwell's Hill (60 m in height) located about 500 m to the northeast, and subtending an angle from 20° to 90°. The remaining three quadrants consisted of open clear fields out to 1 km, and were slightly lower in elevation (40 m) than the tower site. Pine Hill (70 m in height) was located about 1.3 km to the southwest.

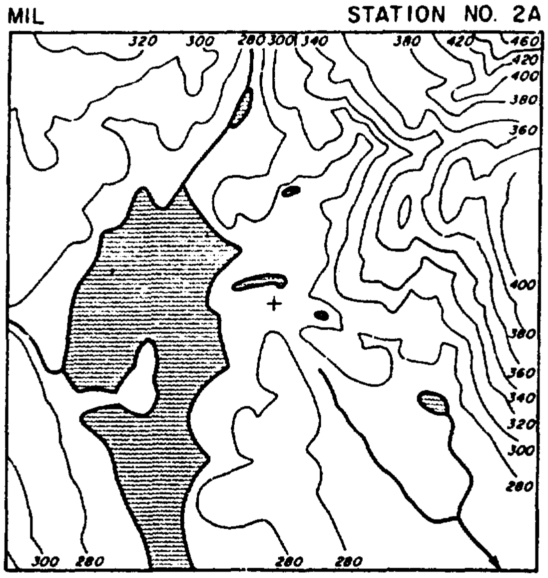

HMP
STATION NO. 1
40
40
20
40
20
1800 M


DEV
STATION NO. 1A
240 220
220
240
240
220
240
260
220

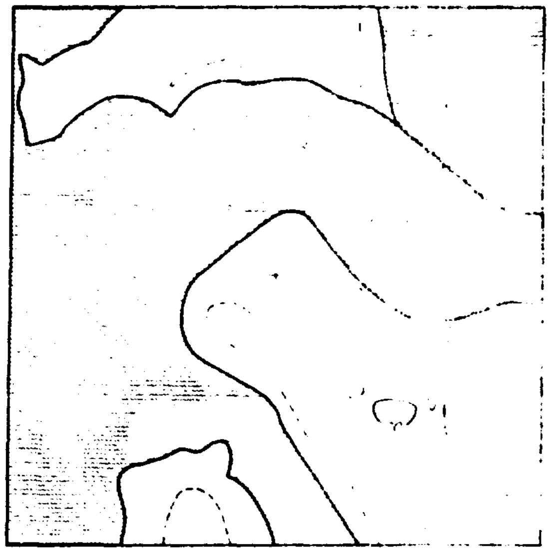
AMS STATION NO. 2



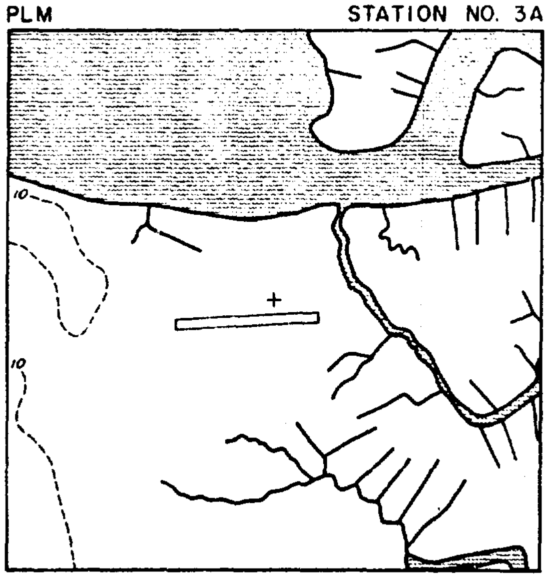
MIL STATION NO. 2A



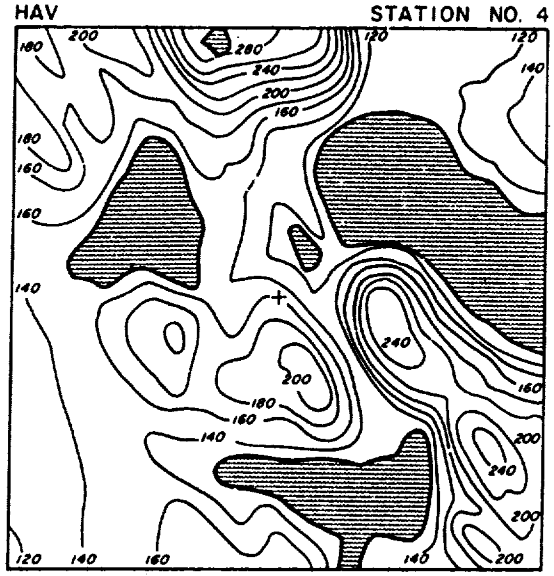
PLM STATION NO. 3



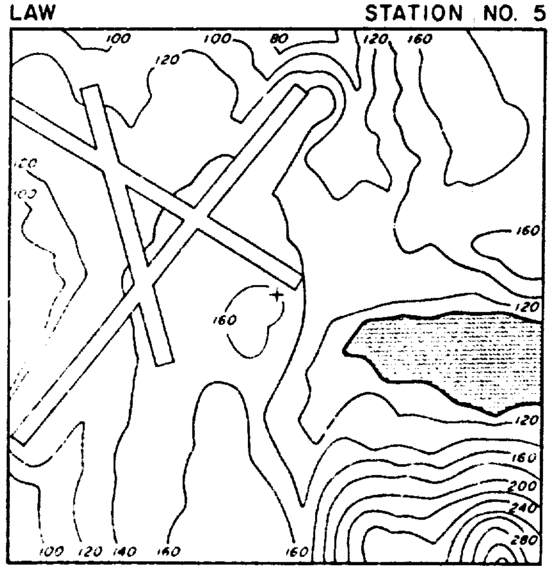
PLM STATION NO. 3A



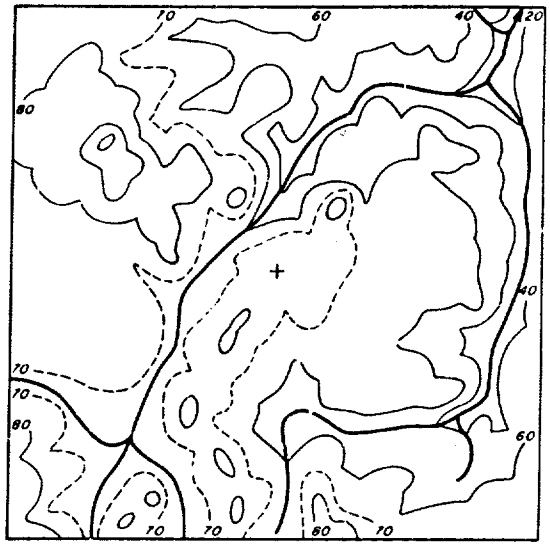
HAV STATION NO. 4



LAW STATION NO. 5



GEO STATION NO. 6



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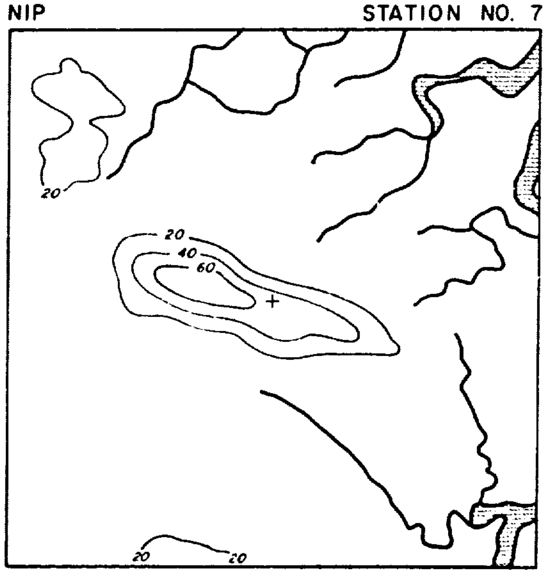

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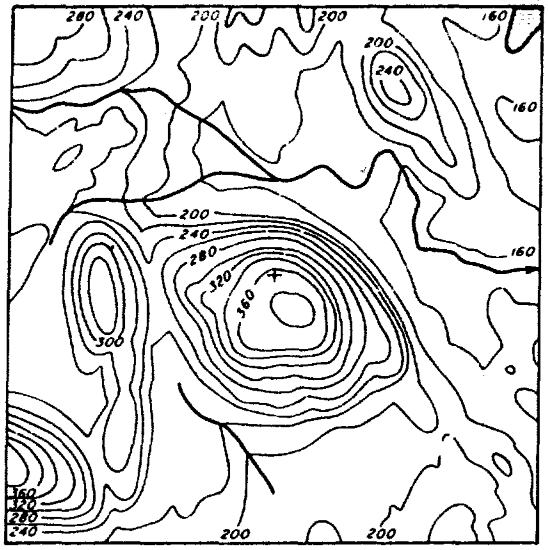

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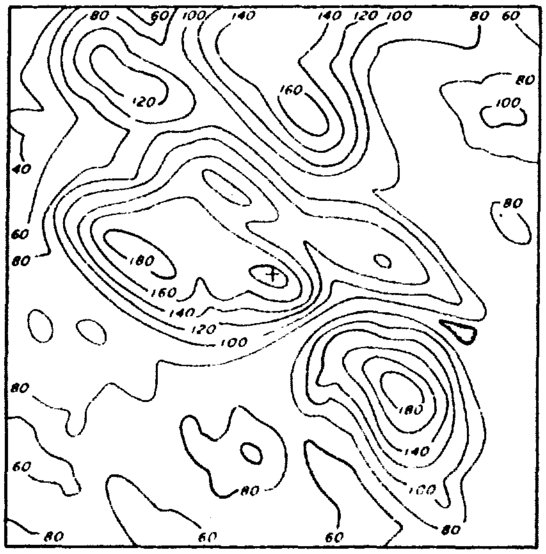

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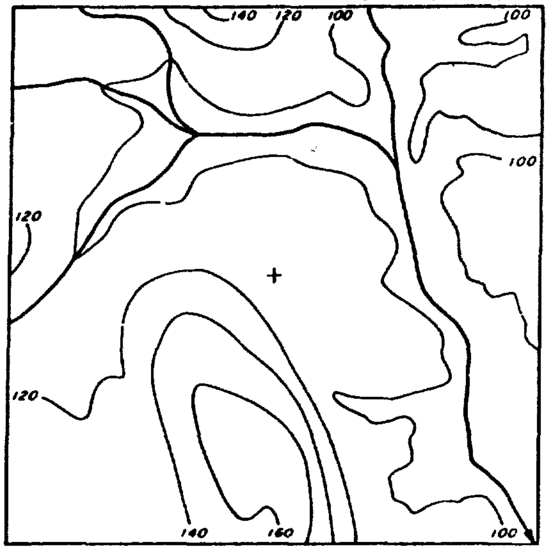

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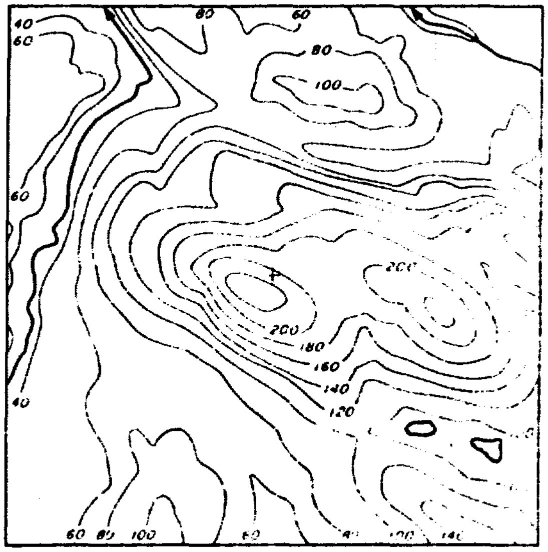
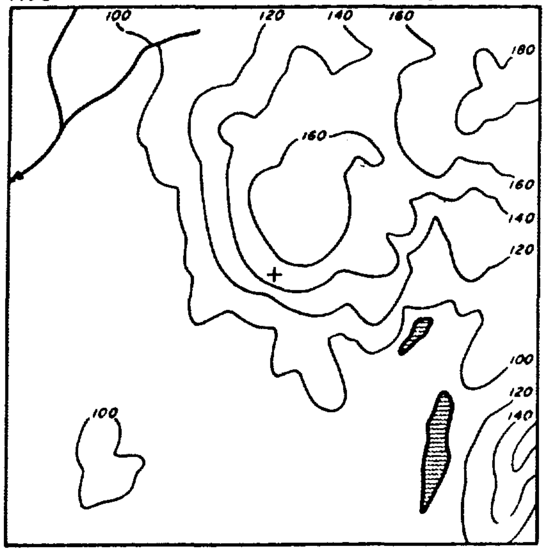
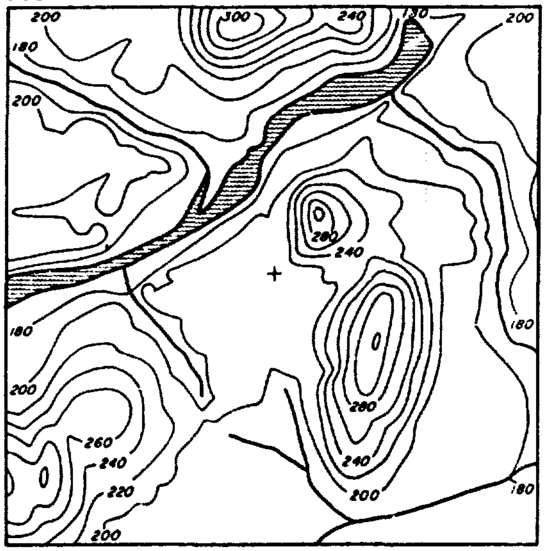


AVC STATION NO. 12



SUD STATION NO. 12A



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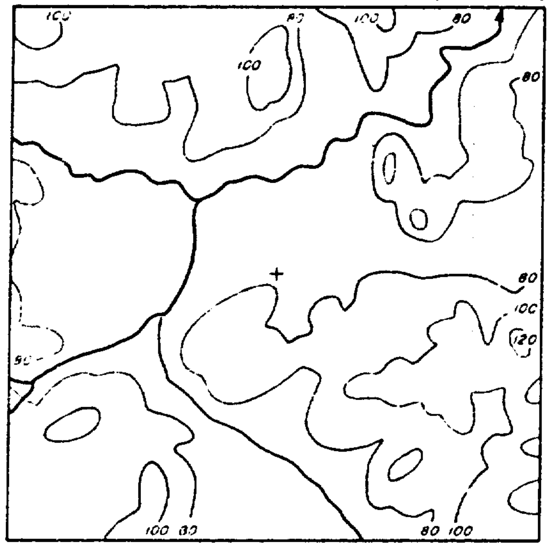

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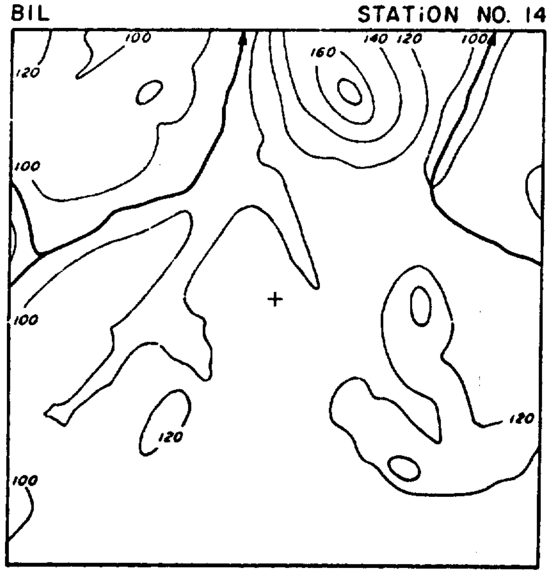

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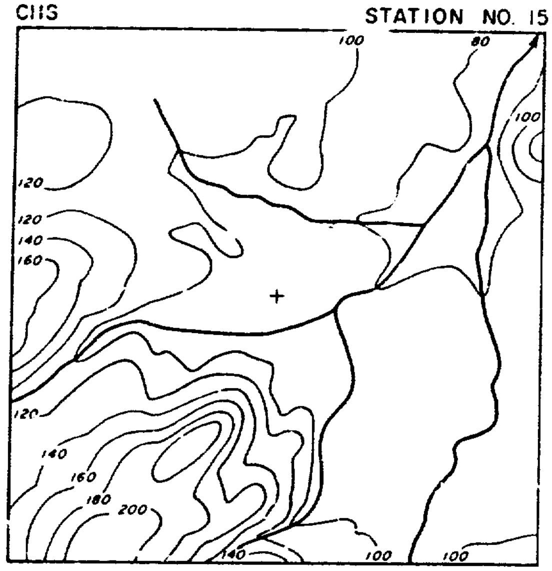

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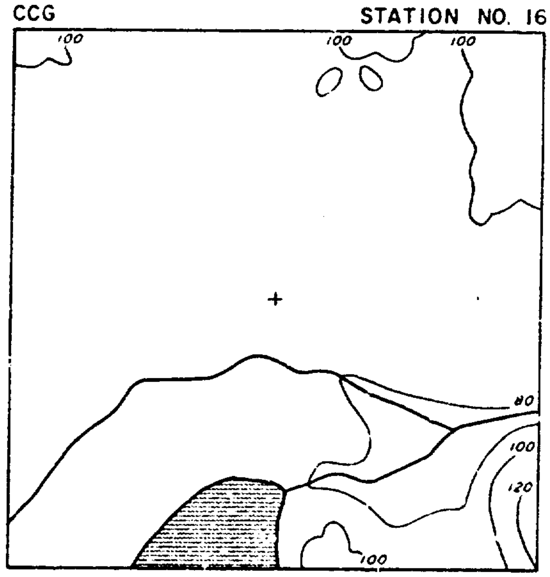

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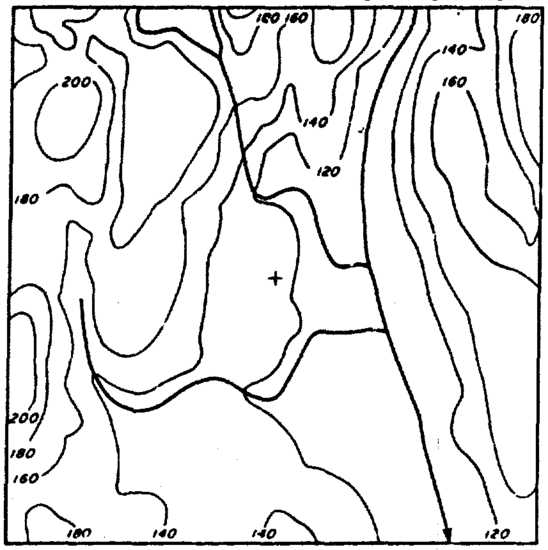

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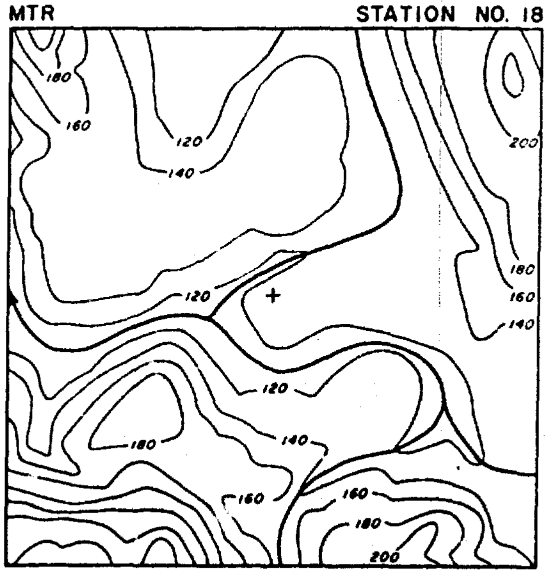

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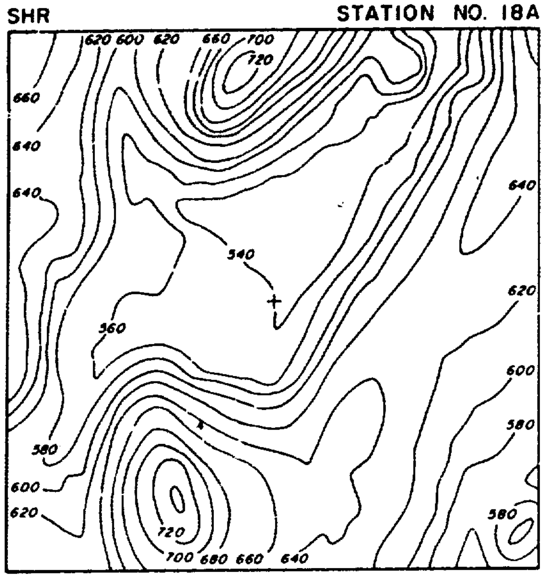

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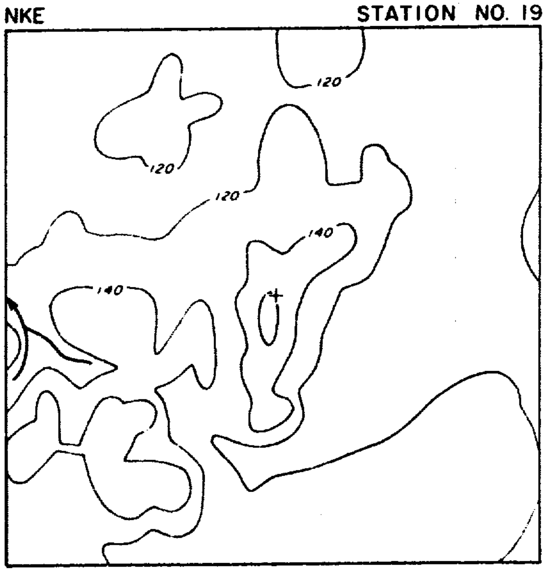

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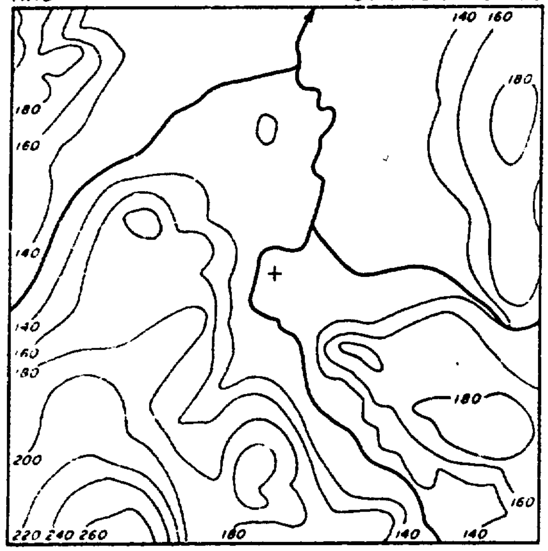

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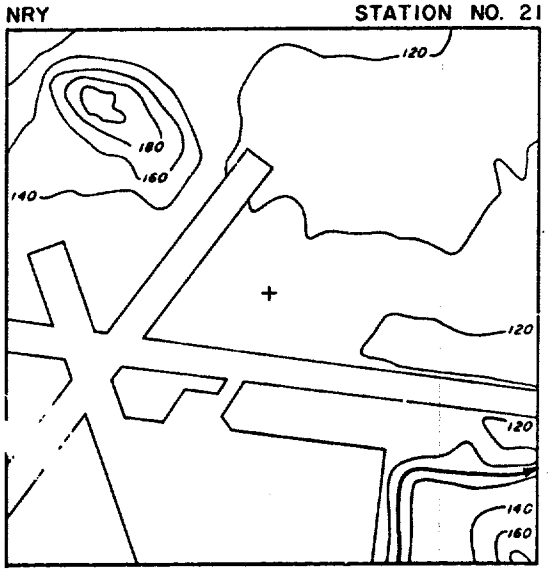

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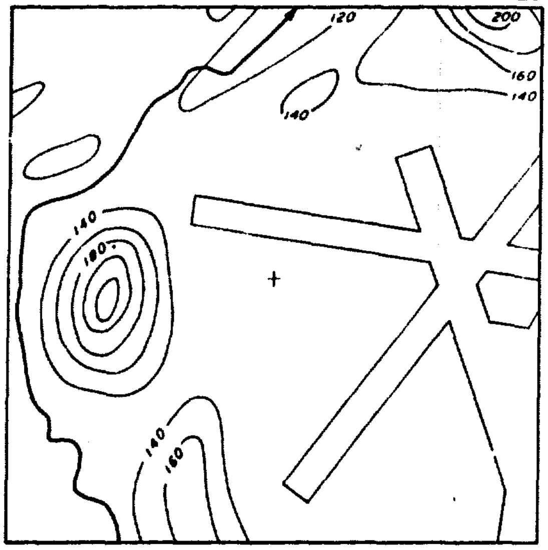

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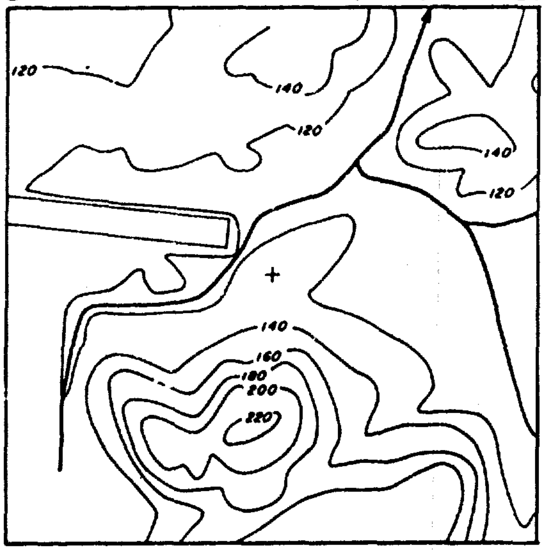
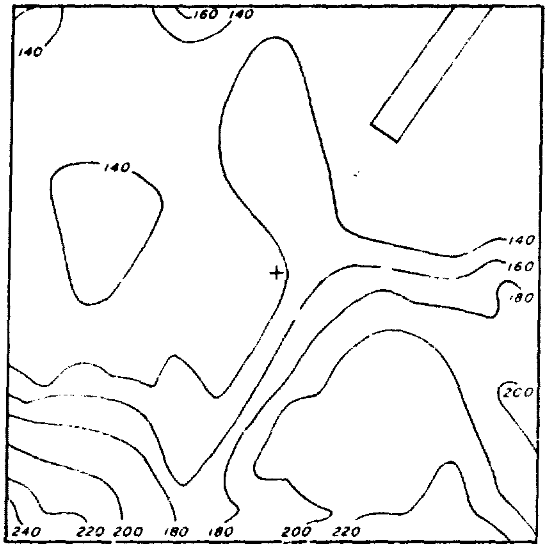
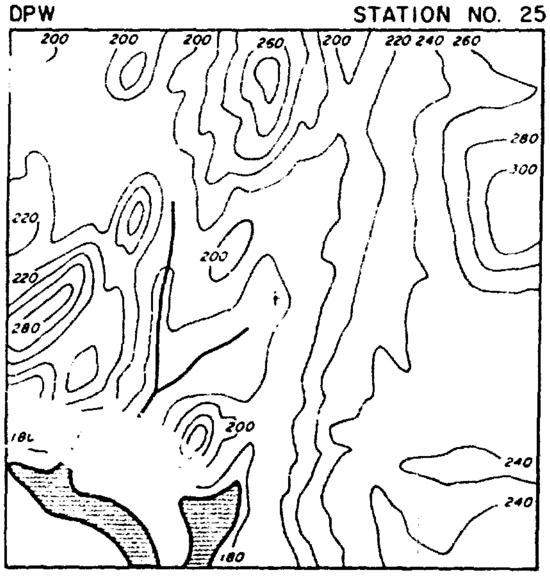


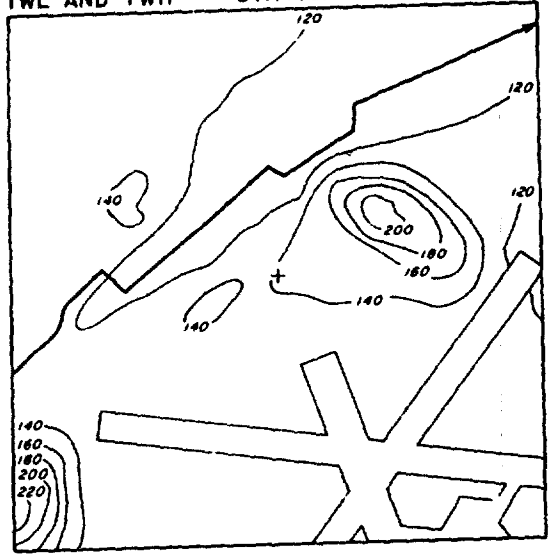
DMP STATION NO. 24



DPW STATION NO. 25



TWL AND TWH STATION NO. 26 AND 28



References

1. Hering, W. S., Brown, H. A. and Muench, H. S. (1972) Mesoscale Forecasting Experiment, Bull. Am. Meteoro. Soc., 53, 12:1180-1183.

2. Hering, W. S. and Quick, D. L. (1974) Hanscom visibility forecasting experiments, Proc. 5th Conf. on Weather Forecasting and Analysis, pp. 224-227.

3. Chisholm, D. A. and Kruse, H. (1974) The Variability of Visibility in the Hanscom Mesonetwork: A Preliminary Assessment, AFCRL-TR-74-0265 AD784791.

4. Tahnk, W. R. (1975) Objective Prediction of Fine Scale Variations in Radiation Fog Intensity, AFCRL-TR-75-0269, ADA014774.

5. Chisholm, D. A. (1976) Objective Prediction of Mesoscale Variations of Sensor Equivalent Visibility During Advective Situations, AFGL-TR-76-0132, ADA030332.

6. Hering, W. S., Muench, H. S., and Brown, H. A. (1971) Field Test of a Forward Scatter Visibility Meter, AFCRL-71-0315, AD726995.

7. Muench, H. A., Moroz, E. Y. and Jacobs, L. P. (1974) Development and Calibration of the Forward Scatter Visibility Meter, AFCRL-TR-74-0145, AD783270.

8. Chisholm, D. A. and Jacobs, L. P. (1978) An Evaluation of Scattering-Type Visibility Instruments, AFCRL-TR-75-0411, ADB010224L.

9. Brown, H. Alb[illegible] (1979) Preliminary A[illegible]essment of an Automated System for Detecti[illegible] Present Weather, AFGL-TR-79-0137, ADA078031.

10. Revised Uniform Summary of Surface Weather Observations (RUSSWO) Part C and D, Station - Bedford, Massachusetts - Air Force Environmental Technical Application Center, Scott AFB, Illinois.

11. Middleton, W. E. N. (1952) Vision through the Atmosphere, University of Toronto Press, Chapter 10, pp. 215-225.